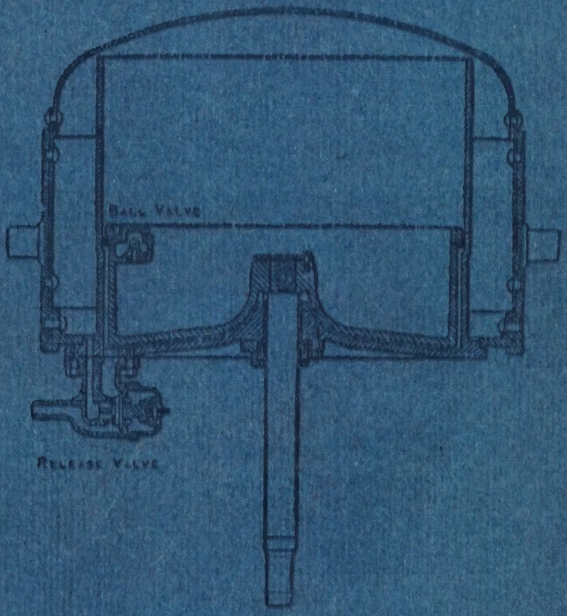
# THE Vacuum Automatic Brake




THE LOCOMOTIVE PUBLISHING CO., Ltd.
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# The Vacuum Automatic Brake

With a Note on

## Slipping Carriages


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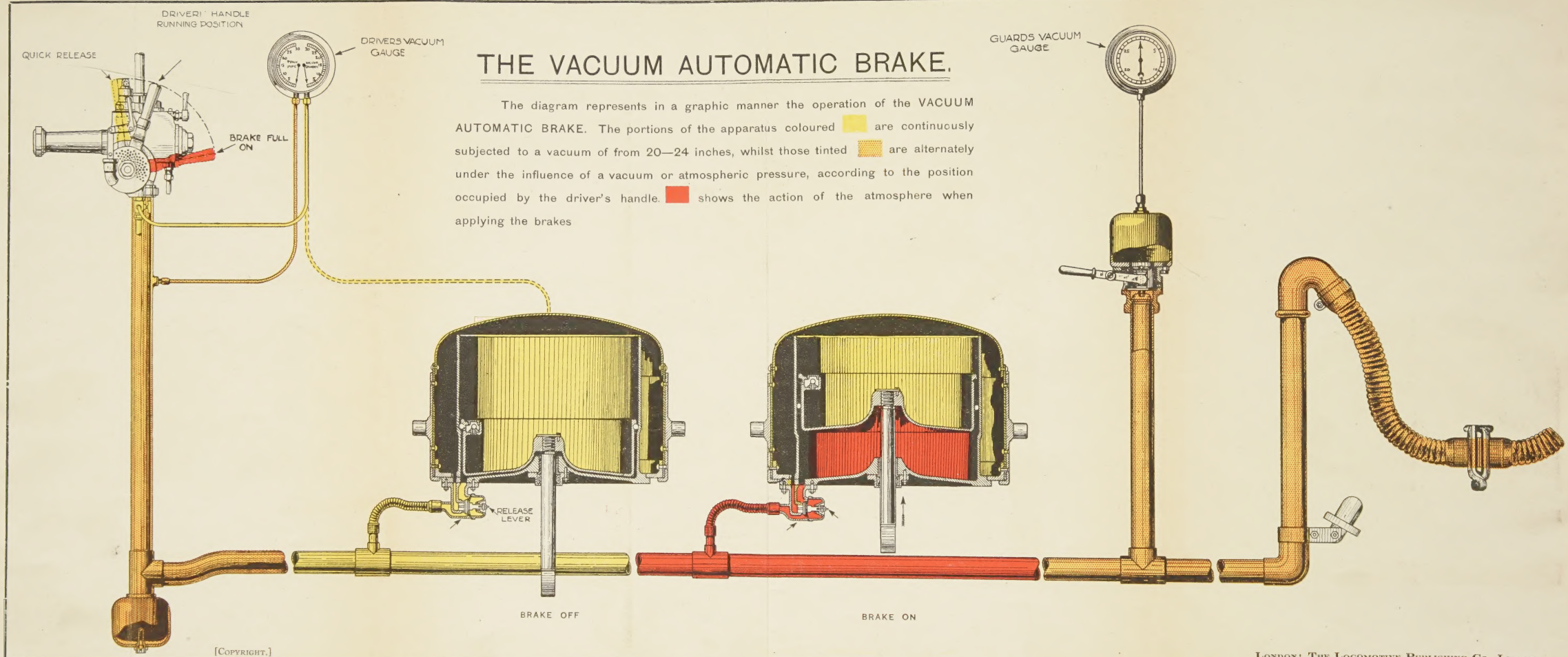
# Vacuum Automatic Brake,

With a Note on

## Slipping Carriages.

# THE VACUUM AUTOMATIC BRAKE.

The diagram represents in a graphic manner the operation of the VACUUM AUTOMATIC BRAKE. The portions of the apparatus coloured ▭ are continuously subjected to a vacuum of from 20—24 inches, whilst those tinted ▭ are alternately under the influence of a vacuum or atmospheric pressure, according to the position occupied by the driver's handle. ▭ shows the action of the atmosphere when applying the brakes



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## PREFACE.

THESE notes are intended for the guidance of the thousands of railway men whose daily duties call upon them to fit up or operate the vacuum automatic brake apparatus. No attempt has been made to investigate any scientific questions involved in the construction or operation of the device used. Simple practical truths have alone been dealt with.

We trust our efforts may prove of assistance to interested readers.

The continued demand for this work has necessitated the issuing of a second edition in which several additions have been made to the text and illustrations.

*October, 1921.*

## CONTENTS.


| | PAGE |
|---|---|
| A vacuum simply explained ... ... ... | 1 |
| The vacuum automatic brake ... ... ... | 2 |
| Ejectors ... ... ... ... ... ... | 4 |
| Combination ejector, type C ... ... ... | 11 |
| " Dreadnought " ejector ... ... ... | 13 |
| " Application valve " ... ... ... ... | 13 |
| " Air clack " ... ... ... ... ... | 16 |
| Metcalfe's ejector ... ... ... ... | 17 |
| Relief and vacuum reducing valve on the ejector | 19 |
| Vacuum brake gear for the engine and tender | 20 |
| Vacuum chamber or reservoir employed with the " separate " type of brake cylinder | 23 |
| " Separate " type of brake cylinder, " E " class | 25 |
| " Combined " type of cylinder, " E " class ... | 28 |
| " Separate " type of cylinder, " F " class ... | 30 |
| " Crab " type of cylinder ... ... ... | 31 |
| " Westinghouse " vacuum brake cylinder ... | 33 |
| Piston rod, stuffing box, and gland, and the rolling ring and ball valve on the piston in the brake cylinder ... ... ... ... | 35 |
| Release valves on cylinders ... ... ... | 39 |
| Drip trap and valve ... ... ... ... | 41 |
| Pumps for maintaining vacuum ... ... | 42 |
| Guard's van valve ... ... ... ... | 44 |
| Guard's application and van valve ... ... | 46 |
| Differential valve ... ... ... ... | 46 |
| Rapid-acting vacuum automatic brake ... | 49 |

PAGE

Rapid-acting valves or "accelerators" ... 51
"Clayton-Hardy" rapid-acting vacuum automatic brake ... ... ... ... 55
"High-speed" vacuum automatic brake ... 59
Positive "load" vacuum brake ... ... 63
The operation of the "load" valve ... ... 66
Hose-couplings, dummy plugs, train pipe, etc. 67
Testing the brake apparatus for leakage ... 69
Automatic steam brake valve ... ... ... 70
Passengers' communication and alarm signal apparatus ... ... ... ... ... 72
Vacuum brake on the G.W.R. (England) ... 75
Vacuum brake on the Midland Ry. (England) 78
Vacuum brake on the L. and N.W.R. (England) 80
Vacuum brake on the L. and Y. Ry. ... ... 84
Fitting up and working of the vacuum brake... 86
Variable power brake ... ... ... ... 92
Quick pull-on brake and wear compensator ... 94
Automatic vacuum brake for electric rolling stock ... ... ... ... ... 96
Vacuum brake equipment on the L. & Y.R. Manchester and Bury electrified section ... 97
Slipping carriages ... ... ... ... 101
Arrangement of slip apparatus on G.W.R. ... 106

## A VACUUM SIMPLY EXPLAINED.

LITERALLY speaking, a vacuum is an empty space, *i.e.*, a space absolutely devoid of any matter capable of exerting pressure.

Practically, a perfect vacuum is non-existent. This is not because we cannot produce apparatus or vessels that would withstand the outer pressure, for this will not exceed 15 lbs. to the sq. in., but because in exhausting a vessel we always leave a residual quantity of the air, or whatever gas it originally contained.

To determine or measure the amount of vacuum we require what is commonly known as a vacuum gauge. This consists of a U tube containing mercury for high degrees of exhaustion and water for low. An exhaustion which would balance a column of water 1 ft. high equals almost exactly 1 lb. pressure or equally a column of mercury 2 inches high. The mean pressure of the atmosphere at sea level equals 14·7 lbs. per sq. in., and for an approximate figure 15 lbs. is usually used, or 30 ins. of mercury. The device used for registering the vacuum obtained for power purposes resembles a " Bourdon " steam gauge both in external and internal fittings, but arranged to operate under opposite conditions.

A good vacuum can only be obtained and kept up so long as no leakage exists. It is well known that leakages are generally the cause of nearly all trouble in connection with vacuum work. As a perfect vacuum is unattainable, the next best, a " partial vacuum," is secured, and for all ordinary purposes may be assumed as being equal to the pressure of a column of mercury 26″ high or the equivalent of 13 lbs. to the sq. in.

The following experiment will help to explain what a vacuum is :—A thin metal vessel is provided, and its ends are securely closed so as to make them air-tight ; at one end of the vessel a tap is inserted (an ordinary gas tap will do very well for the purpose). A little water is passed into the vessel

through this tap, which is left open whilst heat is applied. This latter will cause steam to be formed and drive out the air. The vessel now contains some steam and very little air: formerly it contained air and water. After applying heat for some time the tap at the top of the vessel is closed and cold water poured over it. The reduction of temperature causes the steam to condense, and as water occupies about 1/1650 of the volume of steam at atmospheric pressure, a partially empty space is formed inside the vessel, which is now said to contain a partial vacuum; the external pressure of the atmosphere will cause the vessel to collapse if it is not strong enough to resist it.

A very good instance showing the application of the power of a vacuum may be referred to in the early steam engine of Savery. This was constructed on the vacuum principle, and was called an atmospheric engine, because the work was in reality done by the pressure of the atmosphere on the piston after a partial vacuum had been formed in the cylinder by condensing the steam admitted from a low-pressure boiler.

## DESCRIPTION OF THE VACUUM AUTOMATIC BRAKE.

THE utilization of a vacuum or the pressure of the atmosphere for operating the continuous brakes of railway trains, was early recognised as being a very convenient method of securing power, and has been gradually perfected during the past half century. The original schemes for the purpose, employed simple collapsing cylinders or chambers, from which the air was exhausted by suction whenever the brakes were to be applied. (Fig. 1.) The reliability of such devices was open to question, as the apparatus was only brought into service and the power generated at erratic intervals; in other words, only when required for an application of the brakes. The consequence was that numerous

failures resulted owing to leaks in pipes and derangements of gear.

The introduction of the "automatic" feature remedied these troubles, as it reversed the procedure, the maintenance of a continous state of exhaustion throughout the system, being employed to keep the brakes "off," and any intentional or accidental admission of air resulting in the brakes being "set."

Briefly, the vacuum automatic brake system consists of an air exhausting device, such as a pump or ejector on the engine, a continuous pipe throughout the train maintained in an exhausted state under

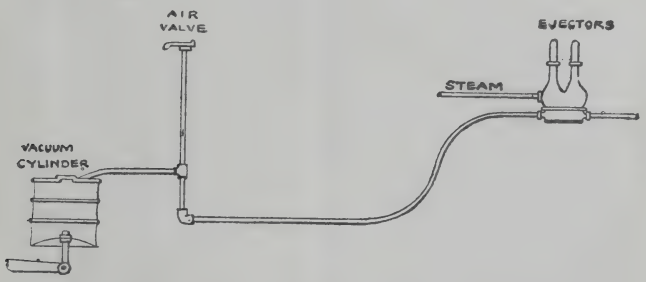



Fig. 1. Diagram of Simple Vacuum Brake.

normal conditions, and a brake cylinder and vacuum chamber (combined or separate) under each vehicle to be braked. In this latter portion of the apparatus a piston is kept in a state of equilibrium by the exhaustion of the spaces above and below it. Air admitted to the train pipe is allowed to exert its pressure on the underside of this piston, but not above it, owing to the intervention of a valve, with the result that the piston is forced up (or inward in horizontal cylinders) and the brakes consequently applied by an arrangement of brake rigging and blocks.

The details of the Vacuum Automatic Brake will be described under different headings, commencing with the ejector or device for creating the power on the engine.

## EJECTORS.

TO create a vacuum, or exhaust any vessel, a pump or steam jet arrangement is necessary, and for the operation of railway brakes both are used. The more common method, however, is by steam jets arranged in a device known as an "ejector." These are usually placed in the cab of the engine and within easy reach of the enginemen.

There are several patterns of steam ejectors in use. Two of the best known are the Vacuum Brake Company's standard combination "C" type and "Dreadnought" patterns, manufactured by Messrs. Gresham & Craven, of Salford, near Manchester, for use with the standard vacuum automatic brake equipment.

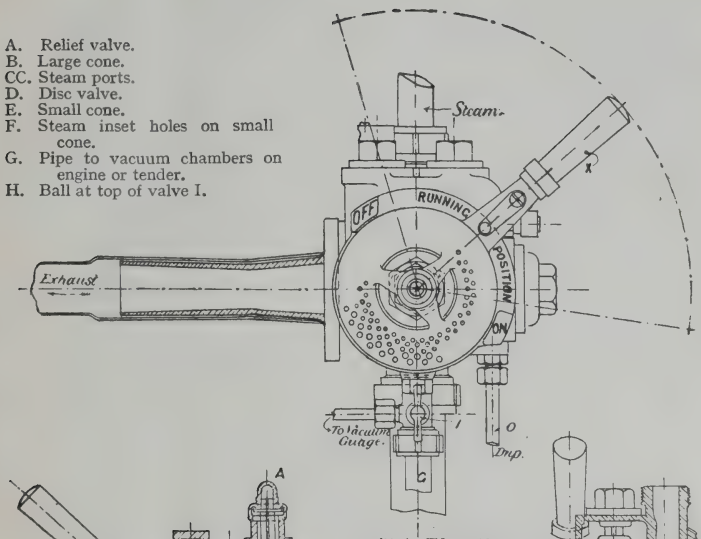
The combination ejector is shown at Fig. 2 in various sections. The chief parts are: application valve, auxiliary air valve, release valve, reducing valve, and air clack. All these are described later.

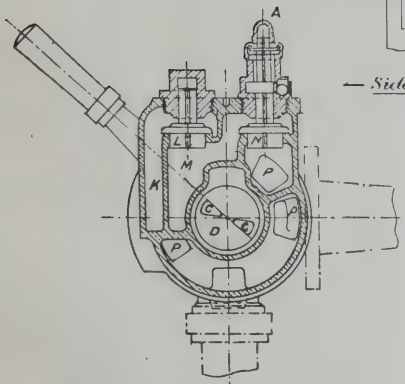
The position of the ejector depends, to a large extent, on whether an exhaust pipe passing through the boiler barrel is used, or an "external" pipe secured along the outside of the lagging. It is usually placed on the driver's side of the foot-plate, on some railways the right-hand side, whilst on others the left-hand.

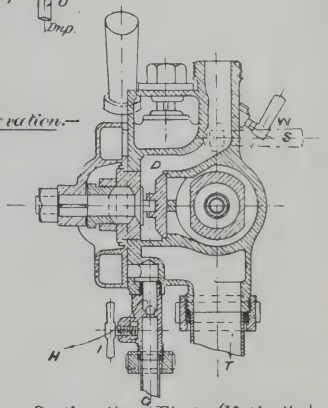
The ejector may be fixed to a bracket secured to the side plate of the cab for an external exhaust; but if an internal exhaust pipe is decided upon, then it may be attached to the flange of the exhaust orifice secured to the fire-box front. Whether an external exhaust pipe is better than an internal one, is a matter of opinion; the internal exhaust pipe is the one most used in Great Britain.

A good plan is to fix the outlet of the exhaust to the top of the blast pipe beneath the blower and above the spark-arrester plate, making a bend in the exhaust pipe to bring it round the cap of the blast pipe and drilling a dozen holes in the annular ring so formed of about $\frac{5}{8}$" diameter. The holes should be drilled so that when the pipe is in position

A. Relief valve.
B. Large cone.
CC. Steam ports.
D. Disc valve.
E. Small cone.
F. Steam inset holes on small cone.
G. Pipe to vacuum chambers on engine or tender.
H. Ball at top of valve I.




I. Valve for releasing brakes on engine and tender after steam is shut off from ejector.
K. Chamber.
L. Wing valve.
M. Chamber.
N. Wing valve.
O. Drip pipe.
PP. Segmental ports.
S. Screw valve for regulating admission of steam to the small ejector.
T. Drip pipe.
W. Lubricating cock
X. Driver's application handle.

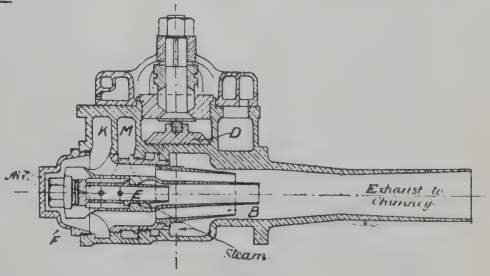



FIG. 2.

they are in the top face of it (see Fig. 3). Some engineers have carried the exhaust pipe up into the chimney.

After an engine has been a period in service, the ejector should be taken off and cleaned by immersing it in a soda bath ; it should be left in this from seven to eight hours. Spirits of salts (*i.e.*, hydrochloric acid) has been used for cleansing the parts of ejectors, but this is not recommended, as it attacks the brass, eating it away and spoiling the surfaces of the discs and seatings. After removing the ejector from the soda bath it should be taken to pieces. This process of stripping the

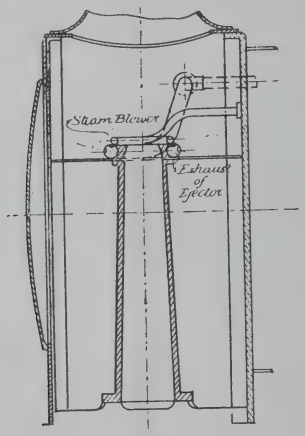



Fig. 3.

ejector is generally done by experienced men under a chargeman, known as the brake gang ; they have a bench either in the erecting or brass shop. After dismemberment it will be found that each part requires separate attention, and for this purpose a nest of shelves lettered to receive the different details should be provided, fixed and running along the entire length of the bench.

The small cone almost invariably shows signs of wear, and usually requires renewing. The action

of the steam continually passing around and through this cone causes a " denture " to appear around the outside surface (see Fig. 4). It is not desirable to grind the area of the cone down to an even surface, as this would make it too thin in section to resist the pressure of steam. It is better to insert a new cone, and a stock of these and other parts are generally kept by the chargeman, who supplies them as required, care being taken at the time of the renewal to make an entry in a book kept for the purpose. This will enable the foremen of the shop to tell at a glance what renewals have been made to the brake apparatus of any particular engine.

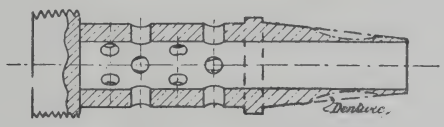



Fig. 4.

The cones of the ejector often get " furred up," due to deposit from the water used in the boiler. In removing the cones care should be taken to start the small one first and then the larger one, because if the small cone be entirely removed before the large, the hole into which the former is screwed is very likely to be " burred " up or distorted by the spanner when removing the large one. It has also been found that when frequent repairs take place the small cone on being replaced in its position will in all probability be found slack on its thread, and will, therefore, screw into its seating too far, thus closing the steam space around it. It is best to make a small " nick " with a file or scriber before removing and then replace and screw up to its original seating, or the cone can be screwed to the place where it was found to work best and a washer of the required thickness placed behind the shoulder. Several of these washers will be required from time to time, they should be of brass or

copper; leather washers are not recommended, because they become soft and unreliable by the heat and moisture of the steam. The steam should be as dry as possible, " wet " steam is not desirable, priming will prevent a good vacuum being maintained, and the water is liable to cut the ejector cones.

A large cone will last the average life of an ejector, which, if properly attended to, will be many years. Ejectors have been at work for upwards of 20 years, and after repairs have again been put into service with satisfactory results. The external exhaust pipe will generally go for about six years without requiring attention. The edges of the discs forming the air valve should be refaced up in a lathe by taking a very fine cut. The disc on being trued-up should be held in a special handle provided for the purpose, and the edges should touch all around those of the ports, care being taken that it does not bear too much either in the centre or on the outside. When an ejector is at work it becomes warm, and if due allowance is not made for expansion the outside edge will open, because the metal is not of a uniform thickness throughout the disc ; it varies from $\frac{5}{32}$" to $\frac{1}{4}$". Sometimes the disc requires lubricating, especially after an engine has been standing idle in the shops or sheds. The lubricating medium should be a very thin oil admitted through the special inlet provided at the back of the ejector, and shown at W (see Fig. 2). Tallow, thick oil, or anything of a similar nature must not be used as it afterwards hardens and causes trouble. The application handle should not be allowed to work stiff, as this cuts the faces. A few drops of oil on the inside of the application valve face should be all that is required. The air-holes on the outer and application disc must be kept perfectly free from dirt.

A good plan adopted on several railways is to provide the outer and " application " disc with a shield ; this tends to keep the air-holes clean. The shield is made of gun metal or cast iron, it has a slit

cut in the side, which fits over the application handle and prevents it being removed and a vacuum created when the boiler is under steam until the proper time arrives for so doing. The handle of the ejector, when not in use, should be brought over to " emergency " or " full-on " position, and the shield fitted into its place. This shield is attached to the air disc by nuts on the outside of the fork of the handle.

Ejectors and all their details are now made entirely of gun metal, but in the older forms some of the working parts were made of cast iron. Gun metal working on cast iron gives the best results for wear, but the latter has the disadvantage of being liable to rust.

No red lead should be used on any joints. This precaution is very necessary, as particles of such material, when hard, get loose and find their way into the pipes, choking them and causing trouble. If, however, it should be necessary to use red lead on any joints, it must be mixed with plumbago and care must be taken not to smear it on the extreme edges of the screw-joints of the pipe.

If any packing be required, such as for the application handle of the ejector, threads from lamp wicks should be used. The threads are soaked in melted tallow and plumbago ; the latter causes the tallow to bind and prevents it working loose.

All the parts of the ejector should be thoroughly cleaned by means of a strong jet of steam before fitting up in their respective places. This ensures that no particles of dirt are left behind. A good plan is to provide a cast-iron box sufficiently large to take all the parts of the ejector and strong enough to withstand the pressure set up by the steam used ; a cover is necessary to the box, securely fastened to the top and made steam-tight with two openings, one at each end, one for admitting the steam and the other as an outlet.

The handles of the ejectors also require care ; they are generally made of hard wood, and when they become too hot are liable to split. A composi-

tion material has been employed, but it has been found to break away from the spindle.

A good alternative, and one much appreciated by enginemen, is to substitute a handle of steel spiral spring of $\frac{3}{16}''$ wire, as shown in Fig. 6; the shape shown has a very neat appearance and is cooler to handle. These coiled handles rarely require any repairs, and are practically everlasting.

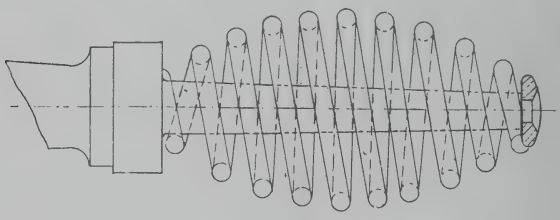


Fig. 6.

The connection between the boiler and the ejector for admitting steam is made through a steam valve or regulator generally placed outside the cab of the engine and on the top of the boiler. This, however, is not to be considered good practice, as the engineman has to get outside every time he wishes to manipulate the valve. It is preferable to place the valve inside the cab where it is under cover and within easy reach of the engineman, taking steam from the whistle standard, or the safety valve seating by means of a pipe leading through the front plate of the cab and thence to the ejector.

The exhaust pipe from the ejector should be at least $2\frac{1}{4}''$ internal diameter throughout, and any bends should be as gradual as it is possible to make them.

## THE COMBINATION EJECTOR. TYPE C.

THIS type of ejector (shown in Fig. 7), although intended for use with the Quick-Acting Vacuum Automatic Brake, may be preferred for service with the ordinary automatic brake. It can be adjusted to work at 20″ of vacuum when desired.

The large ejector steam disc valve is done away with and a valve shown at A of simple construction used in its place ; this valve only comes into operation when steam is admitted to the large ejector, and is not worked with every application of the brake, as with the disc valve in the type B. It will last considerably longer, and having a renewable seating can be kept in repair at a low cost.

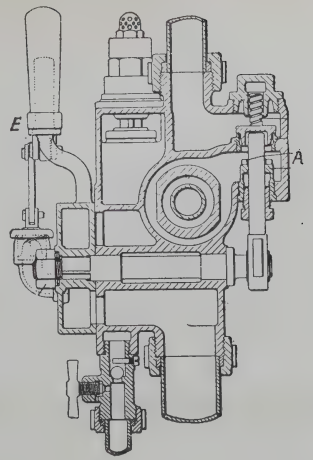
The main air disc valve B is much smaller in diameter, and works very smoothly without lubrication. It has also a definite stop for the running position.

The cones C and D are modified so as to produce a higher vacuum with less consumption of steam.

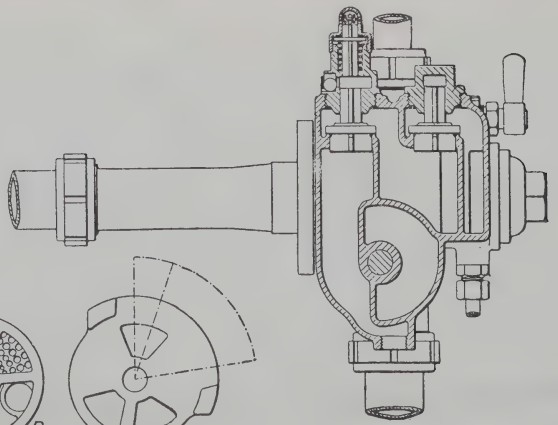
The ejector, it will be noticed, is fitted with an auxiliary application valve E for use when making graduated stops with trains fitted with or without "rapid acting" valves. The use of this valve saves a large amount of wear on the main valve, and, therefore, considerably lengthens the life of the apparatus.

The main features of this type C ejector are the complete isolation of the steam valve C and the arrangements for facilitating the repairs necessary from time to time. The steam and air passages are absolutely isolated one from another, so that there is not the least chance of water finding its way back into the train-pipe.

Cross section, side view.




Section through back pressure valves.





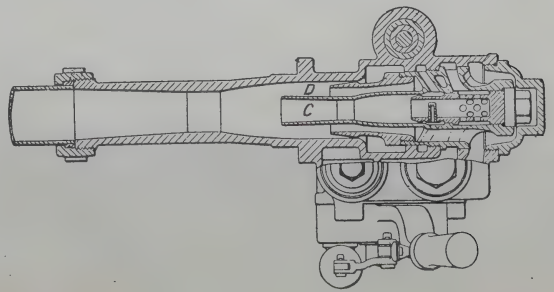




FIG. 7. Sectional plan.

## "DREADNOUGHT" EJECTOR.

THE latest and improved type of ejector introduced by the Vacuum Brake Company is known by the name of the "Dreadnought" ejector. It has been designed in order to meet up-to-date conditions of working, brought about by the ever-increasing length of trains, and consequently greater cubical capacity of brake fittings and increased opportunity for leakages. It is shown in Fig. 7A.

This ejector is interchangeable with type C ejector shown in Fig. 7. The same details are used with only two exceptions. The new parts consist of the cones and the small back stop valve between the large and small ejectors. All parallel joints have been done away with, and fittings made to be screwed solidily up to the shoulders.

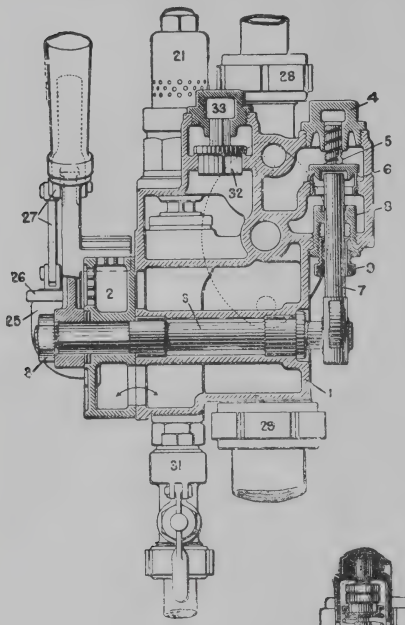
The new cones, as will be seen from Fig. 7A, are extremely simple in construction, and do not depend for their efficiency on delicate adjustment in the body of the ejector. Also the steam jets do not wear away on the bodies as well as the cones. The "Dreadnought" ejector is also fitted with new designs of vacuum reducing (21) and release (31) valves. The reducing valve is so designed that it does not open until the pre-determined vacuum is reached, thus greatly shortening the time required to release the brake.

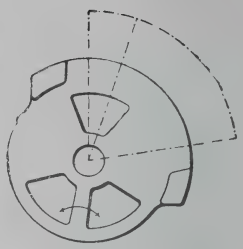
The new release valve (31) has larger passages and consequently acts quicker; it also returns to its seat automatically, thus obviating any risk of being inadvertently left open.

The retaining valve leading to the engine and tender vacuum chambers can be easily examined, and kept in good order without disturbing the body of the valve or breaking any pipe joints. No release valves on the engine and tender cylinders are necessary when this valve is provided.

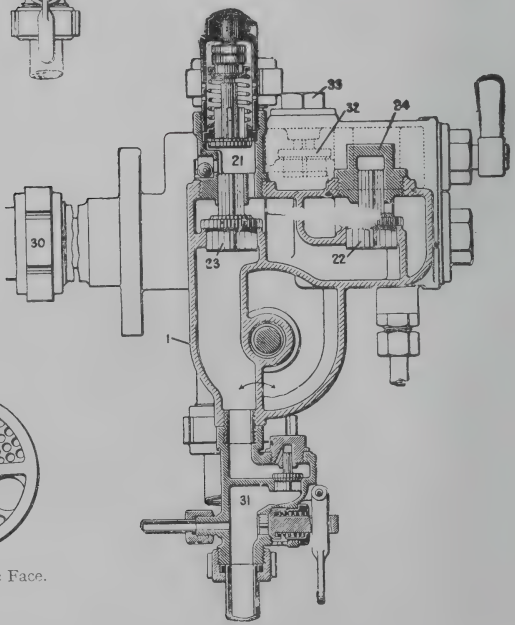
The application valve is controlled by the driver's handle mounted on the same spindle. It has three

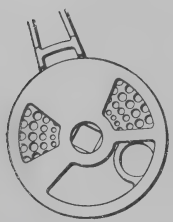
# "DREADNOUGHT" COMBINATION EJECTOR.



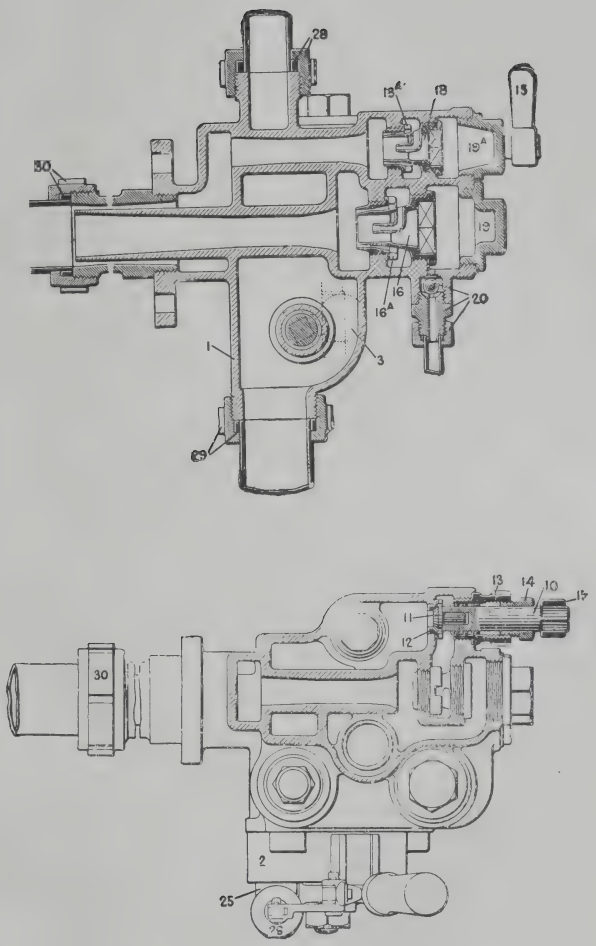
View of Ports in Body.



View of Air Disc Face.

FIG. 7a.




1 Body.
2 Air Disc.
3 Shaft.
4–9 Large Ejector.
10–15 Small Ejector.
16 Large Nozzle.
17 Nozzle Carrier.
18 Small Nozzle.
19 Cap.
20 Drip Connection.
21 Vacuum Reducing Valve.
22–24 Air Clack.
25–27 Auxiliary Application Valve.
28 Steam Pipe Union.
29 Train-pipe Union.
30 Exhaust Union.
31 Release Valve.

FIG. 7a.

main positions: "Off," "Running," and "On." In the "Off" position the steam valve of the large ejector is opened, and this ensures rapid release of the brakes by quickly creating vacuum.

In the "Running" or intermediate position steam is shut off from the large ejector, but is admitted to the small one, thus maintaining the necessary vacuum in the train pipe.

In the "On" position steam is shut off, and air ports opened admitting atmospheric air to the train pipe, destroying the vacuum therein, and applying the brakes.

It will be understood from the drawing that any movement of the handle between the "Running" and "On" positions will regulate the admission of air, and consequently control the power of the brakes In reverse, a movement from "On" to "Running" position will decrease the admission of air, and as the handle approaches the latter the influence of the small ejector will be to slowly recreate vacuum and release the brakes. For a rapid release the handle must be moved into the "Off" position to secure the assistance of the large ejector.

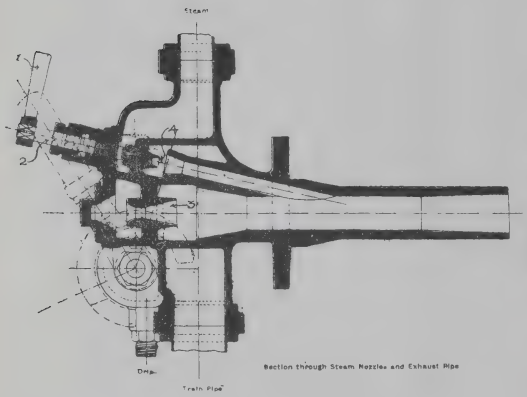
The air clack on the ejector is used to retain the vacuum on the train pipe side should the small ejector be shut off for any purpose. The action of the air clack, No. 23, Fig. 7A, is to drop upon its seat the moment the small ejector is shut off, closing communication between the exhaust pipe and train pipe. If there was no back pressure valve here, air would be able to pass direct from the exhaust into the train pipe and so destroy the vacuum.

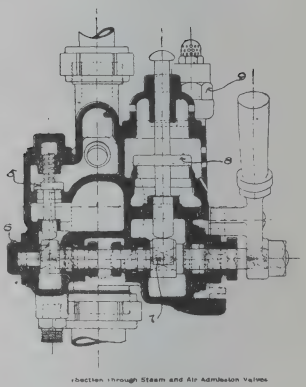
## METCALFE'S EJECTOR.

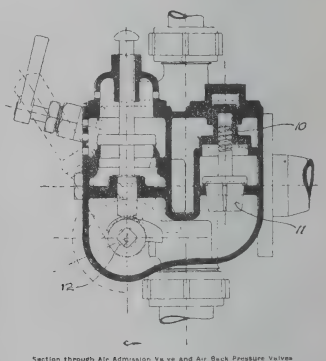
THE working and maintenance of this type of ejector is extremely simple. When running the small ejector steam valve (2) Fig. 7B is opened, and the steam issuing from the steam nozzle (4) passes through the draft tube, and so into the exhaust pipe. A vacuum is created in the small ejector chamber, and the air is drawn through the lower back-pressure valve from the train pipe, so maintaining the vacuum in the latter. The driver's handle being in the running position, both the main steam valve and the air admission valve are closed.

When the driver's handle is moved to the " Brake on " position, the air admission valve is opened by the cam (7) acting on its lower stem. Air then passes into the train pipe, and so to the brake cylinder. At the same time the connection between the small ejector and the train pipe is cut off by the auxiliary valve, the small ejector then drawing only from the engine vacuum chamber or cylinder through the release valve. On again returning the controlling handle to the running position, the cam is moved and allows the air admission valve to close. At the same time the auxiliary valve is opened, and the small ejector draws both from the train pipe and engine vacuum chamber.

On moving the controlling handle to the " Brake off " position, the large ejector steam valve is opened by its cam (6), when steam passes directly to the large ejector steam nozzle (3), creating a vacuum in the ejector chamber, and drawing air past the back-pressure valves from the train pipe. The ejector is fitted with a relief or snifting valve (9), which can be set for any desired vacuum.




1 Small ejector handle.
2 Steam valve.
3 Large ejector nozzle.
4 Small ejector nozzle.
5 Steam valve.
6 Steam valve cam.
7 Air valve cam.
8 Air valve.
9 Relief valve.
10 Top back pressure valv e.
12 Bottom back pressure valve cam shaft.

FIG. 7B.

## RELIEF AND VACUUM REDUCING VALVE ON THE EJECTOR.

THIS valve is shown at Fig. 8; it plays an important part in the operation of the brake, as it prevents an excessive vacuum being formed. A maximum vacuum can rarely be created on two

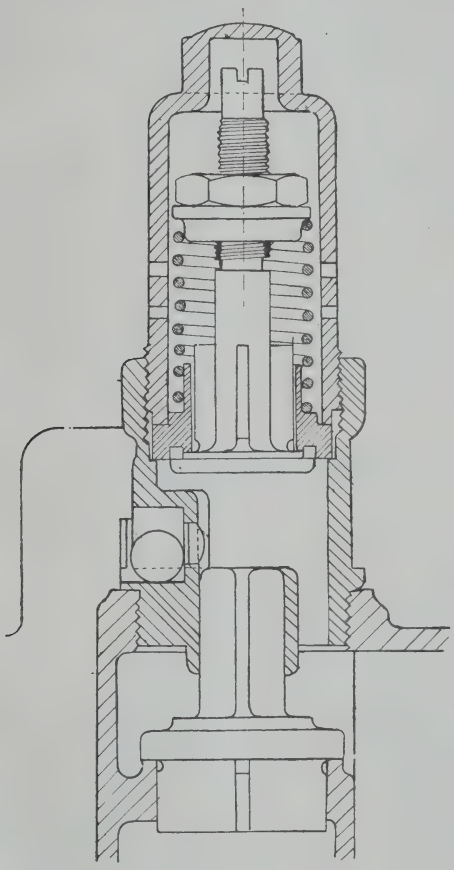


FIG. 8.

engines alike, and therefore it is absolutely necessary that some precaution should be taken to guard against one engine not being able to do the work another has done. For example, a train

requires two or three changes of engines on its journey. Each of these engines may be of the same class, but the driver of the engine used for the second division of the run may find that he is unable to release the brakes on the train, because the ejector on his particular engine will not do the work of that of the engine used over the first part of the run. In the event of two engines being used to head a train, too, this valve is a necessity. The relief valve comes into use and prevents an excessive vacuum being raised by either engine. Fig. 8 gives a sectional diagram of this valve.

The valve is fitted with a spring so adjusted that when the vacuum rises above what is required the atmospheric pressure outside forces it down and enters, thus preventing too high a vacuum being raised.

Why two ejectors never produce the same vacuum when working in unison is difficult to explain, but the steaming power of the boilers may have something to do with it. In like manner, two boilers rarely steam alike.

## VACUUM BRAKE GEAR FOR THE ENGINE AND TENDER.

IN the standard form of brake arrangement, utilizing vacuum apparatus for operating the brakes on the engine and tender, as well as throughout the train, an auxiliary and independent pipe provides communication between the vacuum chambers of the engine (or engine and tender as the case may be) and the ejector. This enables the brake power of the engine to be treated as separate from that of the train. The auxiliary pipe is shown in the drawings of the different combination ejectors, and is marked " G " in Fig. 2. Under normal conditions this " maintaining " pipe is under the constant influence of the exhausting action of the small ejector, and is operated by a " grip " attached to the handle of the application valve, a constant vacuum is thus secured in the upper part of the cylinders and this is especially useful in making a gradual application and " service stop " with quick-acting brake

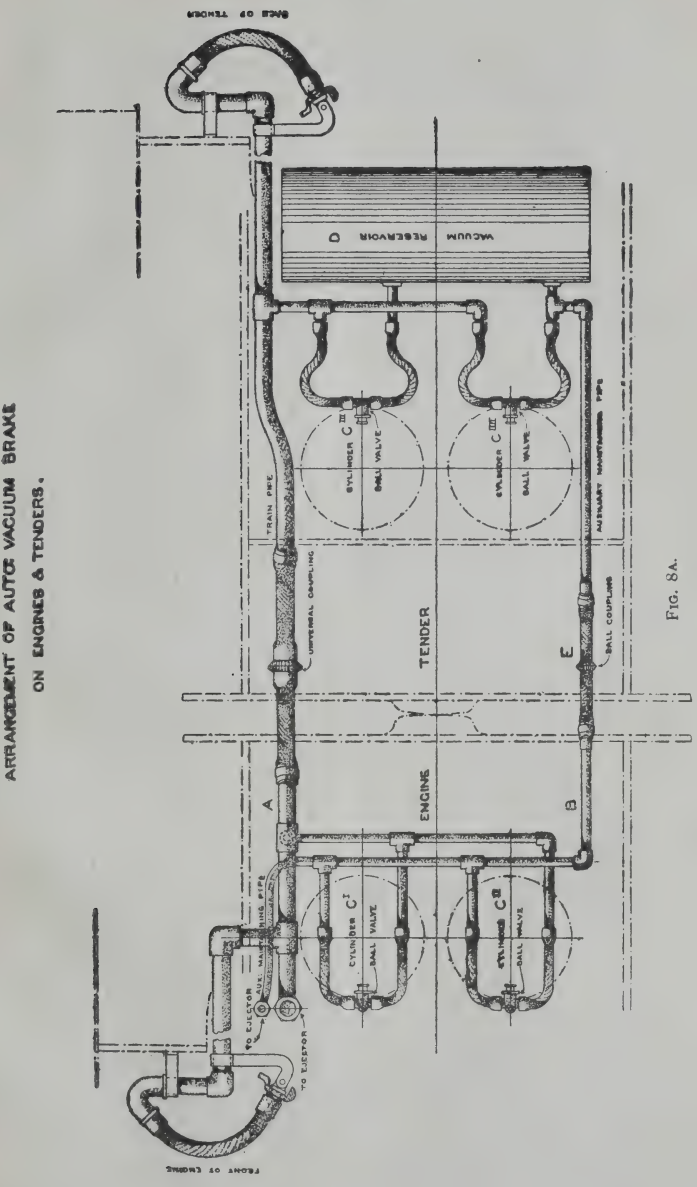

ARRANGEMENT OF AUTO VACUUM BRAKE
ON ENGINES & TENDERS.
BACK OF TENDER
FRONT OF ENGINE
D
VACUUM RESERVOIR
CYLINDER C III
BALL VALVE
CYLINDER C III
BALL VALVE
TRAIN PIPE
UNIVERSAL COUPLING
TENDER
AUXILIARY VACUUM PIPE
BALL COUPLING
E
A
ENGINE
B
CYLINDER C I
BALL VALVE
CYLINDER C II
BALL VALVE
TO EJECTOR
TO EJECTOR

FIG. 8A.

arrangements. The vacuum gauge registering the degree of vacuum existing in the engine chamber is in direct connection with it.

Fig. 8a gives the complete arrangement of piping, vacuum chamber and cylinders under the footplate of an engine and tender. " A " is the main pipe, " B " the " auxiliary " or " maintaining " pipe for the engine and tender only, C′ C″ C‴ C⁗ the brake cylinders of the engine and tender respectively, and D the vacuum chambers. A ball valve is introduced in the tender coupling of the auxiliary pipe at " E "

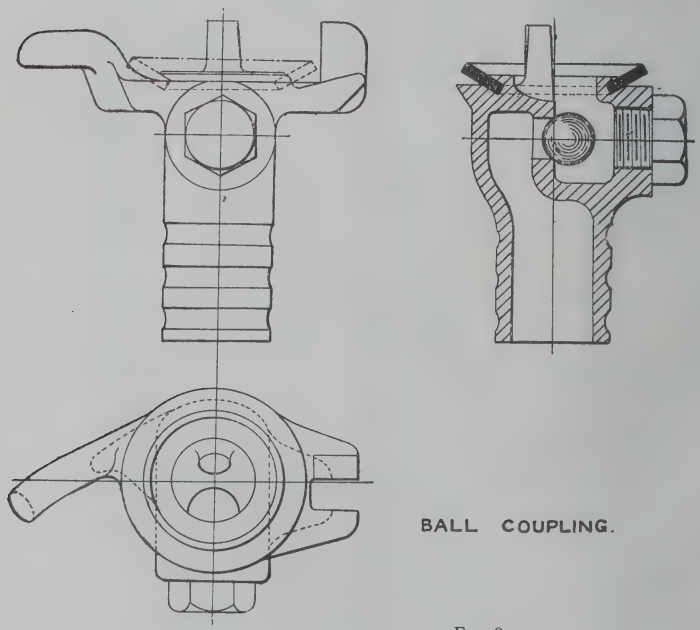



Fig. 8b.

to further guard against loss of power by accidental severance or damage of any of the connecting hose pipes, joints, etc. A detailed drawing of this ball valve coupling is given in Fig. 8b.

Release of the engine brake can be effected by admitting air into the auxiliary pipe by the valve " H," Fig. 2, but the tender brake must be released

as on a carriage, by easing the release valves of the cylinders owing to the intercepting ball valve at the tender coupling.

A word of warning should be inserted here, as to the reading of the vacuum gauge provided for the engine vacuum chamber, it *represents the state of affairs on the engine only*, and must not be assumed to show the vacuum existing in the chambers or above the pistons on the vehicles forming the train. It is true the good working conditions of the brake apparatus on the engine should be reflected as closely as possible throughout the train, but manifestly on an application, the effective pressure in the carriage cylinders must be somewhat reduced, owing to the decrease in the cubical contents of the chambers by virtue of the movement of the pistons necessary to take up the slack of the gear and bring the brakes blocks into contact with the wheels.

It will be seen from the foregoing that an air-tight and perfect condition of all the pipes and connections forming the auxiliary vacuum system of the engine and tender is most important, and all details should receive the same careful inspection that is accorded to the other working parts of the locomotive.

## THE VACUUM CHAMBER EMPLOYED WITH THE "SEPARATE" TYPE OF BRAKE CYLINDER.

THE best and most accessible position for the vacuum chamber on a tank engine is in the rear, under the coal bunker; on a tender engine it is usually placed beneath the tender. If placed in front of the engine, as sometimes is the case, it necessitates extra lengths of pipes being used. This chamber is provided at the bottom with a screw plug to let out any condensation or liquid that may collect. The capacity of the vacuum chamber depends, of course, upon the size of brake cylinders in use.

As already explained, the separate type of brake cylinder differs from the combined pattern. Fig. 9 shows the vacuum chamber in use with two 21″ brake cylinders, that is, one on the engine and one on the tender.

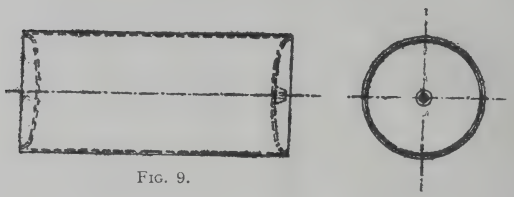


Fig. 9.

There is only one connection from the vacuum chamber to the brake apparatus, *i.e.*, a pipe leading to the ejector, from which there is a branch pipe leading off to the release valve beneath the brake cylinder. This branch pipe carries and connects the vacuum above the piston in the brake cylinder. There are two connecting pipes between the engine and tender; one, the train pipe (2″ diameter) communicates with the ejector and runs throughout the train; through this pipe the brake apparatus on all the fitted vehicles of the train are manipulated. The second pipe also leads from the ejector, and connects to the vacuum chamber; it is called the auxiliary pipe and connects the top side of the brake cylinders with the vacuum chamber of the engine and tender only.

For releasing the brakes on the engine and tender, when not in steam, a special valve is provided in the pipe leading from the ejector to the vacuum chamber. This valve is very simple, both in its construction and action, being a screwed spindle which, when opened, allows the air to pass to the top of the piston in the brake cylinder, thus destroying the vacuum there, and releasing the brakes. This valve is, therefore, in direct communication with the vacuum chamber.

In the "Dreadnought" type of ejector this release valve is of a special design, see Fig. 7A (31). It has larger passages and therefore acts quicker, it also returns to its seat automatically, thus obviating any risk of being left open.

## "SEPARATE" TYPE OF BRAKE CYLINDER. E. CLASS.

THE "separate" type of brake cylinder, shown in Fig. 10, is generally used for the engine and tender vacuum brake; it is arranged under the

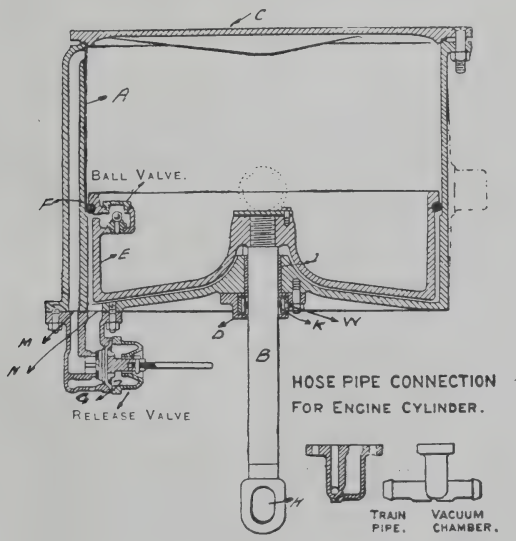



FIG. 10.

footplate and drag-box, this position being the best for nearly all purposes.

The brake cylinder is suspended from brackets (see Fig. 10A) fixed on to and under the drag-box, these brackets receive the trunnions which are provided on the sides of the cylinder. Cylinders of

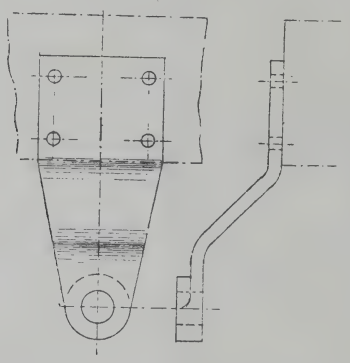


FIG. 10A.

the type shown must not be rigid fixtures, but have provision for an oscillating movement, which is required to give the piston and piston rod freedom in action.

In fixing the brake cylinder, first secure it to the brackets, and then the connections from the vacuum chamber and train pipe should be made fast to the release valve casing fixed to the bottom of the brake cylinder at M N. Next the piston rod crosshead should be secured to the lever or arm of the brake shaft by means of a pin. There are several forms of connection, two of which are shown in Fig 11: the "Hook" and "Jaw" patterns. The brake shaft arm should be a perfectly free fit on the piston rod crosshead; it is usual to allow a space of $2\frac{1}{4}$" between the jaws.

The piston rod of the brake cylinder is coated with brass or otherwise protected to prevent corrosion, which would take place if a plain steel or iron rod were left exposed to the atmosphere; this piston rod

passes through a gland at the bottom of the brake cylinder, in which there is a rubber packing ring, which will be described under the heading of "The Piston Rod Stuffing Box," etc.

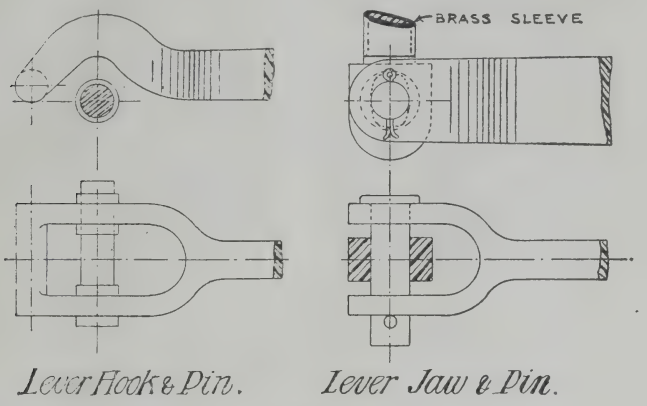



Fig. 11.

No oil or grease should be used on the piston rod, none is required as it is treated for non-corrosion ; the rod will pass through the rubber packing freely by its own action. There is also a brass or white metal bush fixed to the bottom of the cylinder and above the gland ; this steadies the piston rod in its movements. Wipe the piston rod with a dry piece of cloth or waste, every engineman and carriage fitter should provide himself with a piece of material for this purpose. A good precaution is to provide the piston rod with a sleeve, *i.e.*, a cover made of canvas cloth which is fixed to the crosshead of the piston rod and to the gland ; this cover has been found troublesome, however, with goods stock owing to the perishable quality of the material usually used.

## THE "COMBINED" TYPE OF CYLINDER, "E" CLASS.

THIS type of cylinder, shown at Fig. 12, is that which is usually adapted for carriage and wagon stock. It takes up more room than the engine brake cylinder, but there is no attendant vacuum chamber required, as is the case with the "separate" type, where a vacuum chamber is placed adjacent. On a carriage the "combined" brake cylinder is usually placed in a side "bay" of the underframe; its fixing is similar to that adopted for the last described.

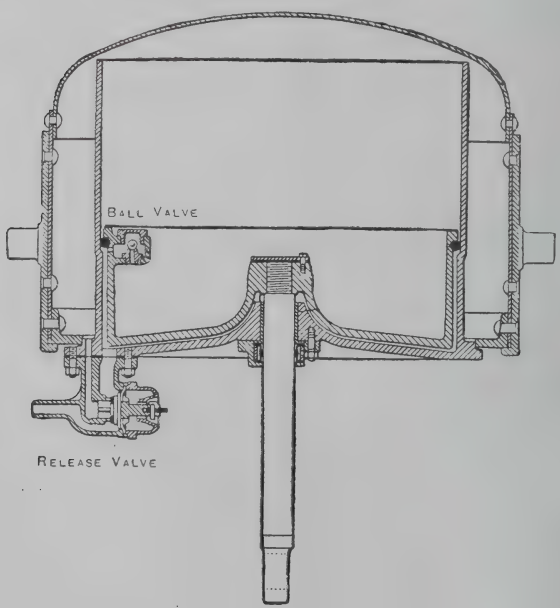



Fig. 12.

The upkeep and maintenance of carriage brake cylinders is similar to that explained in the last chapter. The branch from the train pipe to the release valve on the brake cylinder is partially

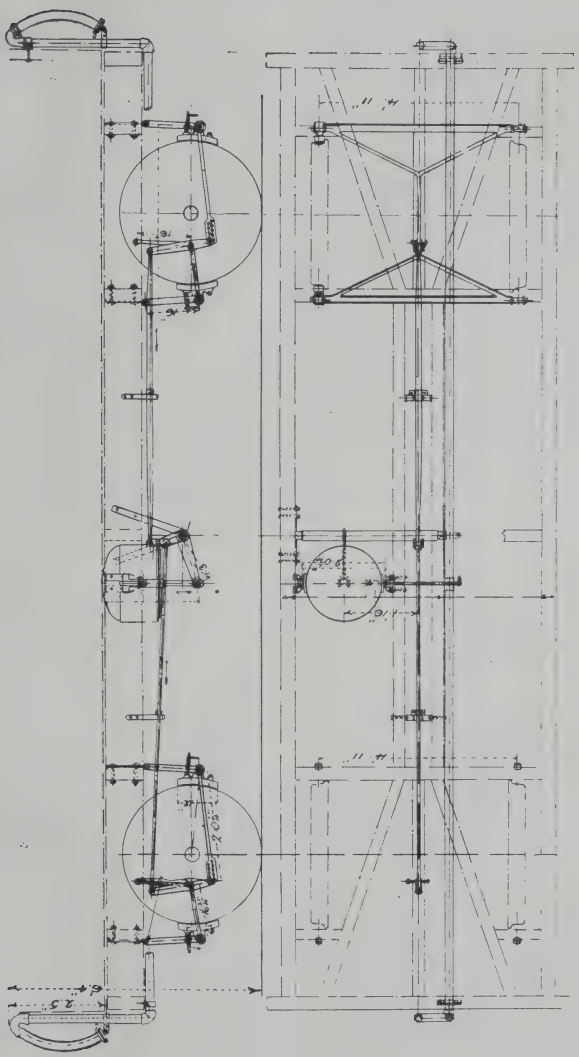


FIG 12A.

flexible, so that the movement of the brake cylinder may be free and easy, as would not be the case if a rigid connection was used. Fig. 12A shows the general arrangement of the fixing of carriage brake cylinders and the brake rigging connected thereto on a four-wheeled carriage or wagon underframe.

## SEPARATE TYPE OF CYLINDER. " F " CLASS.

FIG. 13 illustrates the latest type of brake cylinder introduced by the Vacuum Brake Company. Separate cylinder " F " class. It has been designed to facilitate examination and renewal of the rolling ring, etc., and is fitted with a new type of release valve which is of a reversible pattern. Instead of the lower cover there is a bottom pan, which enables

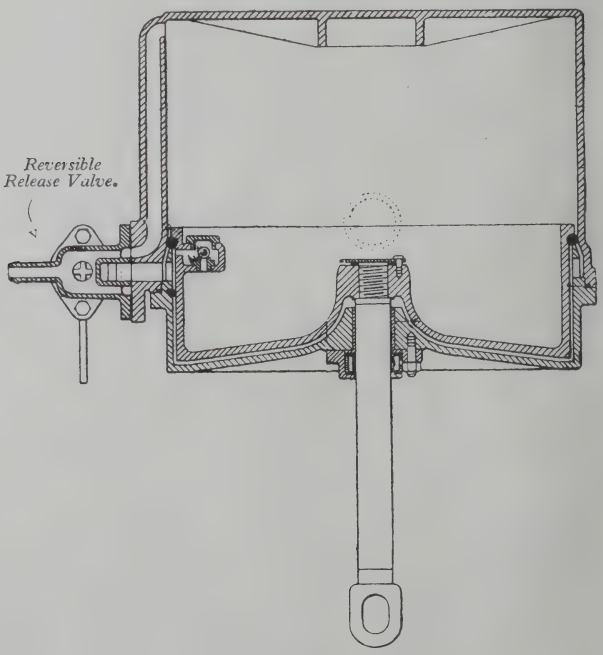



FIG. 13.

the piston to be removed from the cylinder without taking the body of the cylinder down, which, in cases of engines and tenders, is found a great convenience, and more particularly in all cases where heavy, large diameter cylinders are employed.

The release valve is placed on the side of the cylinder where it is generally found more convenient. As this type of valve is made of a reversible pattern it can be turned round with the branch to train pipe pointing in either direction, to suit convenience of fixing so that it is unnecessary to have two patterns, one for each hand.

Another improvement in this cylinder is a guide for the rolling ring, which, in the event of the ring getting out of place, ensures the ring being returned to its groove when the piston has returned to the lowest position. The attachment of the piston rod to the piston has been strengthened so as to prevent liability of the piston rod bending.

## "CRAB" CYLINDER AND "EQUABLE" RIGGING.

THE "Crab" type of vacuum brake cylinder, illustrated in Fig. 13A, has been introduced by the Consolidated Brake & Engineering Co. One of the great advantages of this pattern is that it dispenses with the necessity for brake shafts. The cylinder carries its own bell crank levers, enabling the rocking shaft to be dispensed with. To allow for inequalities of pressure or wear on brake blocks, the cylinder swings on trunnions, and so gives an equal pressure on all brake shoes at all times. This type of cylinder is shown in Fig 37, with use in conjunction with the "Variable Power Brake."

Fig. 13A shows "Tandem" cylinders for bogie stock. This arrangement is used on the London and South Western Railway.

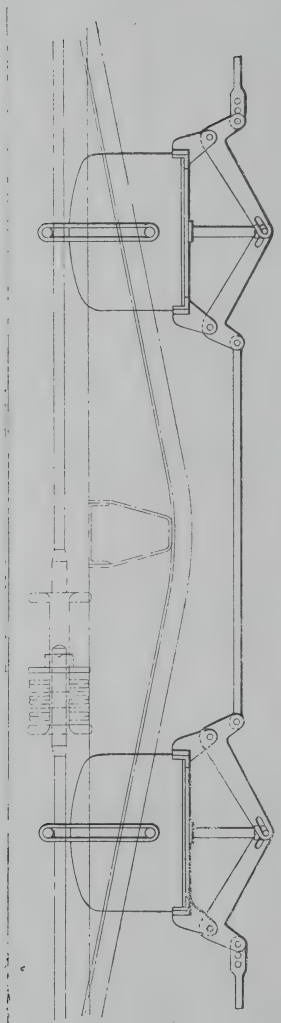


Fig. 13A.

## THE " WESTINGHOUSE " VACUUM BRAKE CYLINDER.

THE diagram, Fig. 13B, shows this cylinder in section. It will be seen that the upper chamber is separated from the lower by a specially prepared diaphragm " 8 " which is so formed, and moves in such a manner, that a smooth surface is always maintained whether the piston " 3 " is at rest or in motion. When this piston is at the bottom of the cylinder it seats on a ring " 9 ", which ensures a tight lower chamber, while the brakes are off, although the annular packing ring " 11 " may possibly be leaky through wear ; thus the consumption of steam through the ejector to ensure an efficient vacuum is economised.

This cylinder is not made to swing on trunnions, but is fixed vertically on the carrying plate on the frame of the vehicle. This arrangement entirely avoids the disadvantages consequent on the use of a flexible connection between the brake cylinder and the train pipe. It also reduces to no inconsiderable extent the wear and leakage between the piston rod and its gland and packing, which, with the swinging type of cylinder, is mainly due to the force necessarily exerted through the piston rod and gland every time the brake is applied, in order to move the whole weight of the cylinder and its attachments, with their attendant friction. This movement is necessary with the swinging type of cylinder in order to accommodate the radial movement of the lever on the brake shaft.

With the cylinder fixed in the manner shown, the pull on the brake lever is effected by a rod pinned to the brake lever and carried thence to the head of the piston, where it is secured by a ball and socket attachment, which permits of the radial movement of the brake lever. The hollow trunk attached to the piston, which works in the gland and packing of the cylinder, allows suitable play for the pull

rod, so that the piston and its rod rise and fall vertically in the cylinder and through the gland and packing, without the constraint of any lateral pull, or friction.

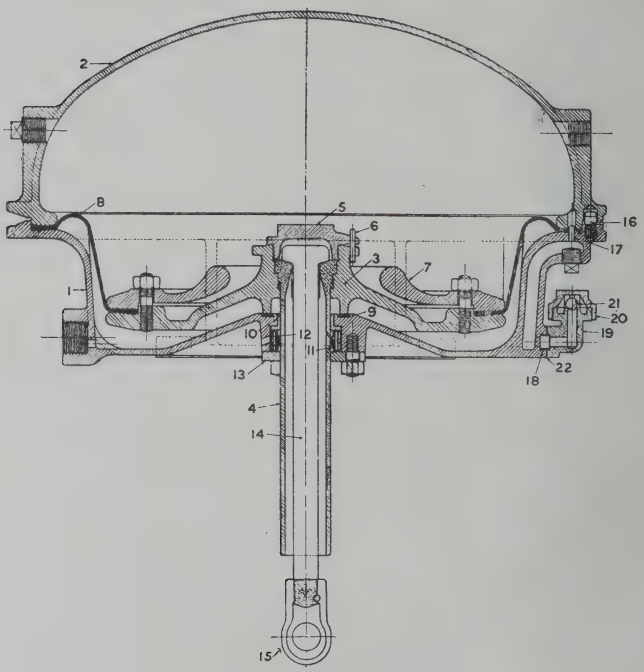



FIG. 13B.

The diaphragm rolls on the curved surface inside the cylinder, which is enamelled to prevent rust and injury to the diaphragm by contact or adherence thereto

The ball valve " 21 " regulates automatically the communication between the chambers above and below the piston.

## THE PISTON-ROD STUFFING-BOX AND GLAND, AND THE ROLLING RING AND BALL VALVE ON THE PISTON IN THE BRAKE CYLINDER.

THE piston rod stuffing-box is made as in Fig. 14. As previously explained the bottom of the cylinder is fitted with a brass or white metal bush, through which the piston rod works. The

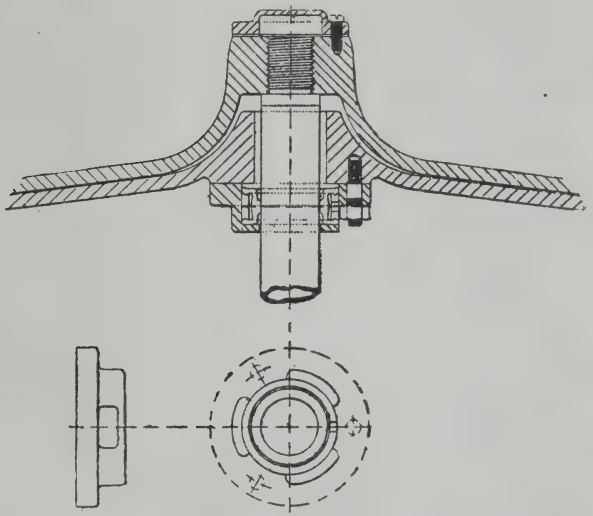


Fig. 14.

packing in the gland consists of a rubber ring, held in position by a brass ring; the top and bottom edges of this ring and of the bush have grooves cut in them, so that when the cap, or cover, is bolted up tight the ring is squeezed into the grooves. In this, as in other details of the brake the action of creating a vacuum tends to tighten the packing the atmospheric pressure being admitted to the outside of the packing ring. When the brakes are applied this pressure is relieved (any leakage into the cylinder being an advantage to the operation of the brakes), and the friction on the rod reduced.

## PISTON RODS.

THE hooked type has been devised with the object of providing a means of repacking piston rods when secured (see Fig. 15) ; that is, rods keyed or otherwise secured to the piston of vacuum brake cylinders to prevent theft. It is also applicable to

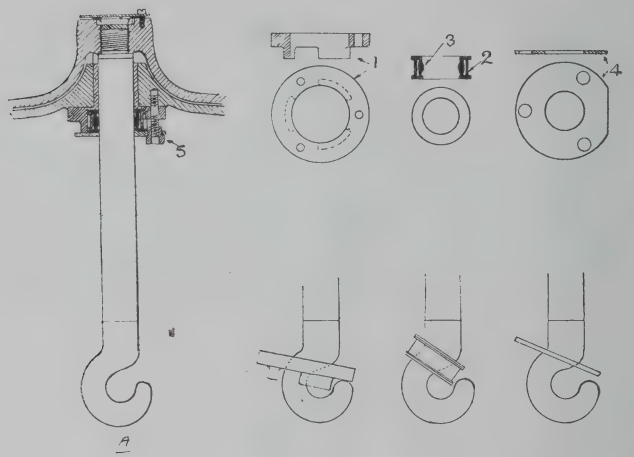



FIG 15.

cylinders without special provision for securing the rods. The special features of the arrangement are : —

(*a*) A hooked end to piston rod ;

(*b*) A built-up packing-box, the separate parts of which are so designed as to be easily detachable, and passed over the hook. The hooked end of the rod is formed so as to allow of each portion of the box being removed, and at the same time is effective in keeping the crosshead pin in position. Fig. A in the diagram shows the general arrangement of rod and box as fitted to cylinder. Fig. 15 shows details of packing box (1), packing box ring (2), rubber gland ring (3), and steel bottom plate (4). The packing-box ring (2) is a steel stamping of special

form, and displaces the brass ring usually employed, thus reducing the loss by theft. A special form of nut (5), A Fig. 15, is employed on the carrying studs. This obviates the necessity for changing the studs ordinarily in use, and facilitates the

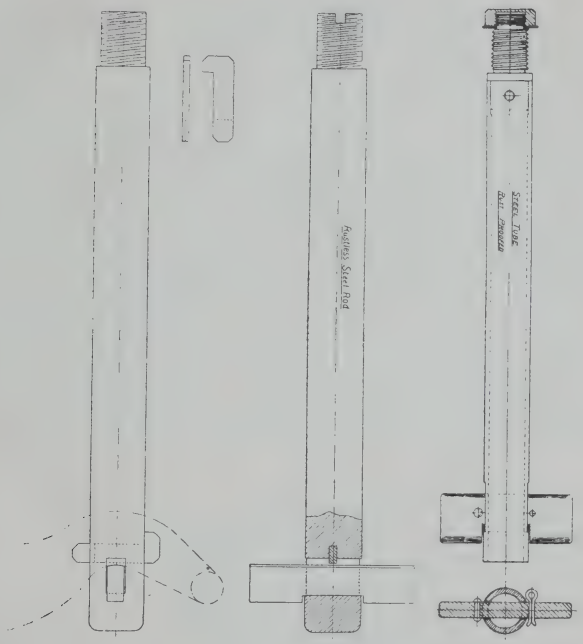


FIG. 15A. FIG. 15B.

fitting of the new box to existing cylinders. The removal of the parts is easily effected by threading them along the rod. When fitting a new gland ring it is not necessary to remove the packing box (1) from the rod. The replacement is, of course, carried out in the reverse order as shown in diagram.

Two forms of " locked " piston rods are shown in Figs. 15A and 15B. The gland packing ring can be easily and quickly renewed by removal of the cross-head pin in either form.

The type shown in Fig. 15B is made of solid drawn steel tube, which is subjected to a special process, rendering it non-corrodable. The surface is highly polished, thus reducing friction with the gland ring to a minimum.

## ROLLING RING AND BALL VALVE.

WHEN putting a rolling ring on to a piston in the brake cylinder care should be taken that it is not twisted. Around the ring will be found a fine seam-line, which should lie evenly and horizontally all round when in the groove. Fig. 15C shows part of the piston containing the ball valve and position of the rolling ring, when the brake is being applied, the piston moving in the upward direction.

The ball valve in the piston is entirely cut off as soon as the piston is moved in the upward stroke, by the hole feeding the ball valve moving to the other side of the rolling ring. Thus the ball valve cannot in any way be affected by external forces.

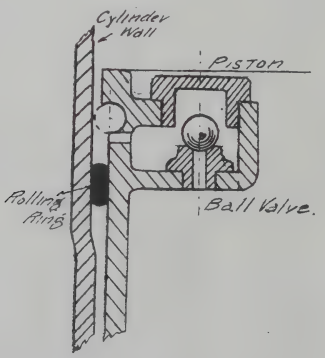



Fig. 15c.

The function of the ball valve is simply to establish communication between the vacuum chamber and the underside of the piston, when the pressure in the former exceeds that in the lower portion of the cylinder.

The action of the valve is as follows :—When a vacuum is created by the ejector on the engine, suction takes place, and the air is withdrawn from the bottom side of the piston, and also from the vacuum chamber above, past the ball valve on the piston, causing the valve to lift off its seat and establishing direct communication between the train pipe, vacuum chamber and top of the piston. Directly air is admitted into the train pipe, this valve is retained on its seat by the atmospheric pressure upon it. Air can now only find its way into the bottom of the brake cylinder, thus forcing up the piston and applying the brakes through the medium of the brake shaft, pull rods, levers, etc. The function of the valve is, therefore, to obstruct the connection between the vacuum chamber above the piston, and the spaces below, which is in direct connection with the train pipe.

The interior of the cylinder is best left rough as it leaves the lathe with the tool marks on it, as the "rolling ring" is then compelled to "roll," and not "slide," as it might do on a highly polished surface.

It will be noticed on referring to the brake cylinder illustration Fig. 10, page 25, that the hole in the crosshead on the piston rod H, through which the pin passes, securing it to the arm of the brake shaft, is not a circular one, but elongated in shape. This is to give a half-inch lift to the piston before the brake shaft is put into action, and allow the ring around the piston a limited movement in its groove, to enable it to become compressed and form a perfect air-tight fit before actually operating the brake lever.

## RELEASE VALVE ON CYLINDERS.

FIG. 16 shows the latest type of reversible release valve in section, as fitted to "F" class brake cylinders, see Fig. 13. This valve is supplied to cylinders on carriage and wagon stock. Fig. 16A shows a section of reversible hose pipe connections for engine and tender cylinders.

It will be noticed that the release valve is provided with a lever attachment for the purposes of moving the diaphragm " 1 " from its seating ring " 2 " when it is required to release the brake after detaching the engine, and the valve will remain open until a vacuum is re-created in the train pipe.

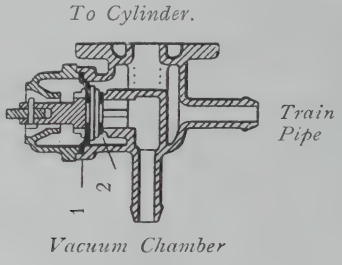
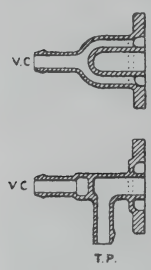



Fig. 16.

When it becomes necessary to release the brakes on any vehicles which have been standing in a station, shed or siding with the brakes " set," it is only necessary to operate the lever of the release valve; this causes the diaphragm to leave its seat in the valve and air passes from beneath the piston in the brake cylinder into the vacuum chamber ; the hose-pipe at one end of the carriage or carriages should be pulled off its dummy, so as to allow the air to enter freely and pass to the top of the brake cylinder. By this means the piston of the brake cylinder is restored to a state of equilibrium.




The weight of the piston in the brake cylinder assists to release the brakes, hence there is no need for springs on the brake rigging beneath the carriage to bring all back to normal position.

Fig. 16a.

In most vacuum brake apparatus no "isolating" cock is in use as in compressed air systems for cutting out the brake apparatus on any vehicle when it is defective.

Should any mishap occur with the brake apparatus on any vehicle on a train, and time does not permit of uncoupling and removing it, a temporary "cut-out" of service can be made by severing the flexible pipe leading from the train pipe to the brake cylinder, plugging up the end hanging loose by means of a piece of wood driven hard into it, so making a through pipe. If time permits and the necessary material is at hand a piece of thick sheeting made secure by means of strong twine should form a covering to the wooden plug and pipe. Such a defective vehicle should, however, be removed from a train as soon as possible and repaired.

## DRIP TRAP AND VALVE.

THE drip-trap and valve shown in Fig. 17 is placed on the engine and generally at the very lowest position of the train pipe; a good place is at the bottom of the length leading from the

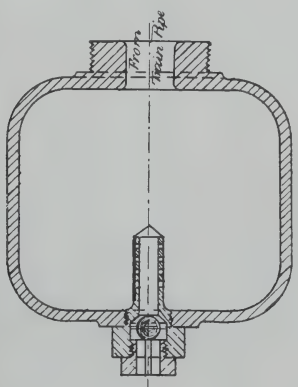



FIG. 17.

ejector. There is a self-acting ball valve fitted to the bottom of the drip-trap valve; this ball falls

from its seat when the vacuum in the train-pipe is destroyed, and allows any condensed water to drain out.

As a rule little condensed water is found to collect at this valve, but if there should be any considerable amount detected it will be due to a leakage at the back stop valve of the ejector. The holes in the recess at the bottom of the ball valve of this drip-trap valve must be kept clear and free from dirt. It is advisable for a fitter to clean these holes out occasionally, and make sure the valve is in perfect order.

## PUMPS FOR MAINTAINING A VACUUM.

IN the United Kingdom several railways employ pumps to maintain vacuum.

The advantage of the pump is that no "live" steam is required from the boiler whilst running; it can be of very simple form, as will be noticed on referring to Fig. 18, which shows a section through one of those used on the Great Western Rly. It is worked off one of the crossheads, generally the left-hand, of the engine; this pump gives very little trouble in working and maintenance.

The pump has its disadvantages, one being that at times it creates an excessive vacuum which necessitates a relief valve on the train-pipe. A very high vacuum further interferes with the use of the Passengers' Alarm Signal, as will be explained later.

The relief valve should not allow the vacuum to exceed 20″, thus preventing it becoming excessive.

If a pump is found to leak or is faulty in its action, it is best to stop the branch pipe at the joint nearest to the pump or the one on the train-pipe, and then use the large ejector only to maintain the vacuum. Sometimes the packing of the glands is at fault; this should be attended to on shed days.

The pump should be lubricated with a fine oil, the same as is used for the discs on the ejector. No tallow or any thick lubricant should be used, as it may get into the train-pipe, and in time find its way to the cylinders.

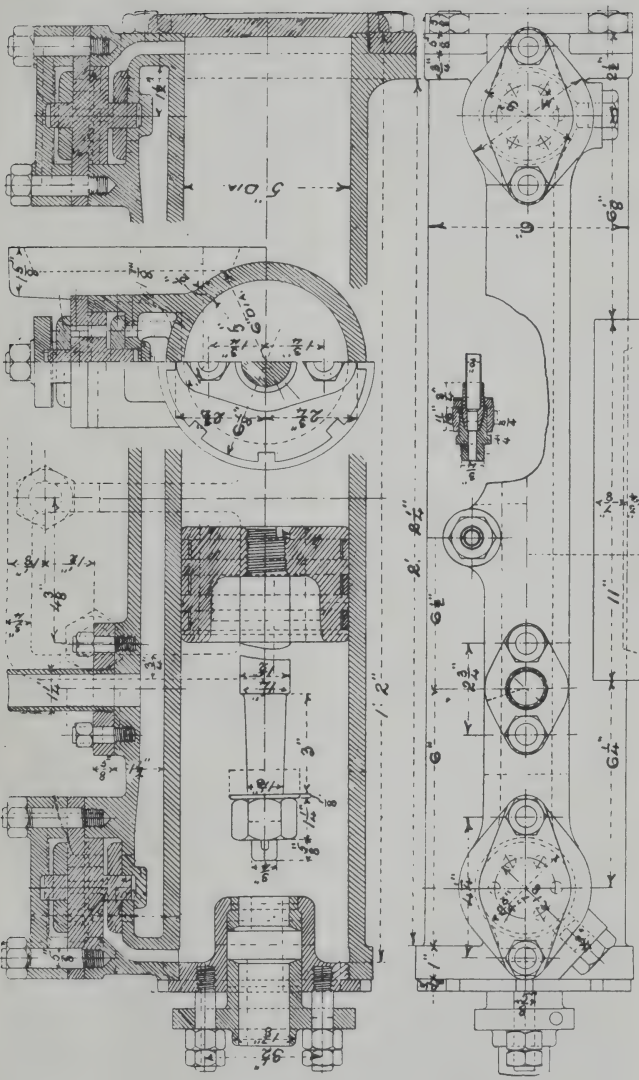


FIG. 18.

## GUARD'S VAN VALVE.

AN illustration of this is given in Fig. 19. The restricted size of the hole B prevents the vacuum in the upper chamber C being rapidly destroyed when air is suddenly admitted to the train

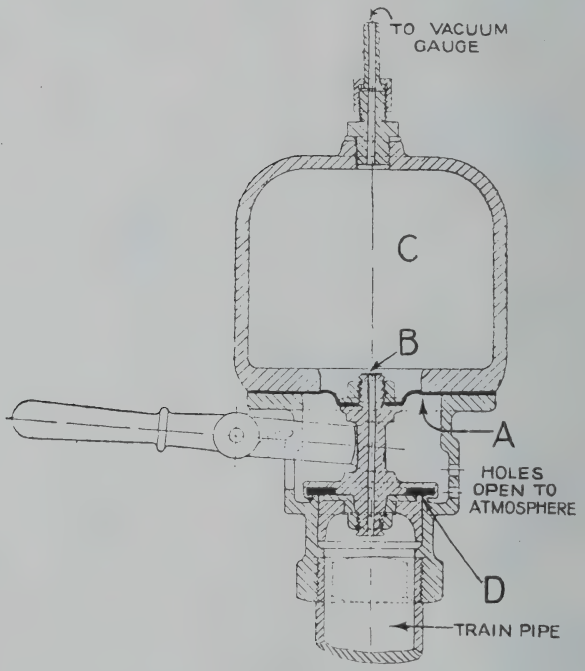



FIG. 19.

pipe. Under these circumstances the pressure of the atmosphere will force up the diaphragm A, and open the valve D, assisting the access of air to the train pipe.

For ordinary service applications the valve will remain closed as the vacuum in the upper chamber will be slowly destroyed by leakage of air through

the small hole ; the weight of the valve D will keep it closed. The valve is usually fixed either against the end of the brake van (inside) or against one of the partitions in the van, within easy reach of the guard. The latter position is chosen if the guard's compartment is in the centre of the vehicle.

The action of this valve should be tested to make sure the diaphragm is free before any long run of a train is undertaken, although it rarely gets out of order, and is seldom used as compared with the other working parts of the brake; it is advisable therefore to test it.

Care should be exercised when fixing and fitting the valve up to see that the connection from the vacuum chamber at the top of it to the vacuum gauge is securely made. A small leakage there will prevent the degree of vacuum being correctly registered by the pointer on the dial of the gauge, and the guard consequently does not know the exact vacuum existing in the train-pipe and brake apparatus.

The air-holes surrounding the inlet or application pipe should be clear from dirt, and it is as well to provide a shield for this, the same as on the ejector, but care should be taken to fit the shield so as not to interfere with the movement of the application handle, and prevent air from entering freely when required.

Instructions as to the use of this emergency brake valve should be printed and placed in such a position that guards and shunters may read and understand how to use it.

The rubber diaphragm should be changed at intervals as it becomes distorted and may stick.

It should also be mentioned in connection with the emergency brake valve that the more brake vans there are in a train fitted with this, the more sensitive the action of the brakes becomes, and the more rapidly the brakes will operate, for each valve will automatically open and freely admit air to the train pipe as soon as the equilibrium

of the diaphragm is sufficiently affected. The whole of these van valves should instantly act on a "full" application being made by the engine-man, the parting of the train, or the hose-pipe at the end of the last vehicle of the train coming off its dummy.

## GUARD'S APPLICATION AND VAN VALVE.

IN view of the increased volume and speed of traffic working, it has been found advantageous to put in the hands of the guards of the trains, power to gradually apply the continuous brake without necessarily making an "emergency" application. As previously described, the existing van valve is so arranged that by depressing the handle a valve is opened, making a full application of the brake; also when the driver makes a full application from the locomotive, the van valve automatically opens and admits air into the train pipe at each van valve in the train, thus increasing the rapidity of application. In the improved combined application, van valve and gauge, it will be seen from Fig. 19A, the application valve has a small disc, with a handle by which the guard can conveniently regulate the admission of air to the train pipe, through a special nozzle, which is so arranged that, when working between the stop and the centre notch there is no possibility of an emergency application being made, whereas beyond the centre, a full application is always secured, at the same time, the automatic feature of the valve is retained for emergency use.

## DIFFERENTIAL VALVE FOR OPERATING AIR AND VACUUM BRAKES.

THIS valve is shown in Fig. 20. It is fitted on locomotives equipped with air pressure brakes and working vacuum trains, and is intended to enable the driver to apply the air brake on the engine simultaneously with the vacuum brake on the train.

It is fixed between the ejector and the train-pipe, and its action is as follows : The piston in the body of the valve is $2\frac{1}{4}''$ in diameter, therefore, when the ejector is at work (producing a vacuum of, say, 20″) the total

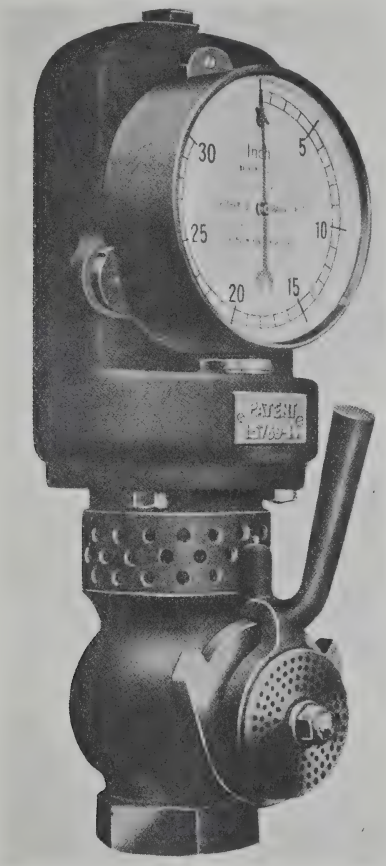



Fig. 19A.

pressure due to the atmosphere having access through the holes on the left side of the piston will be approximately 40 lbs., the seating of the valve is $\frac{5}{8}''$ in diameter, and assuming the pressure in the compressed air brake pipe to be 80 lbs. per sq. in., there

will be a total force of 24·5 lbs. only acting against 40 lbs. on the piston ; it is, therefore, obvious that the valve will remain closed until the vacuum is reduced by the admission of air into the train-pipe in which case the valve will be opened and the compressed-air brake applied by the escape of air from the train-pipe through the small holes provided. When the vacuum is restored the valve, assisted by a spring, closes, this spring can be adjusted by the

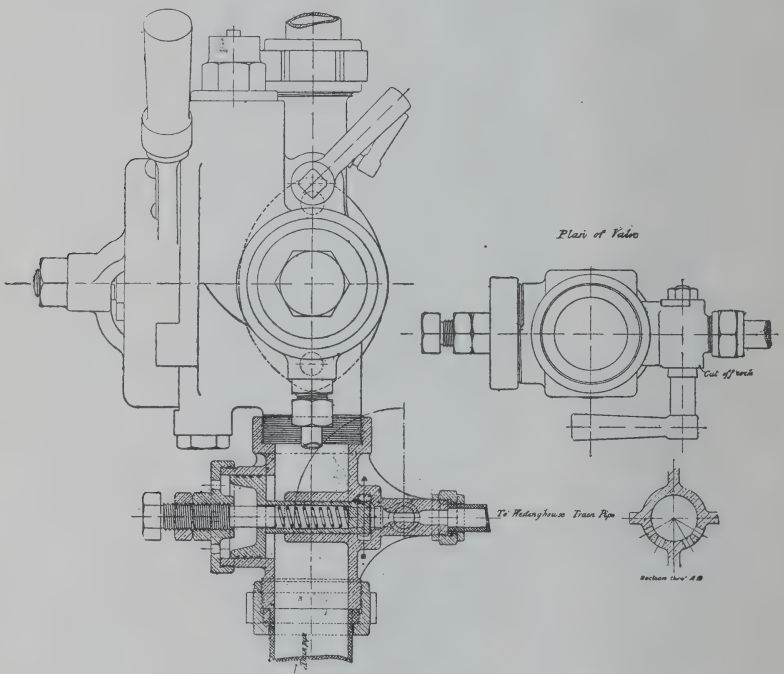



Fig. 20.

set screw which projects through the valve casing at its side. A cock is provided for this differential valve for shutting off the connection between the two brake systems. By using this valve in combination with an ejector an engine fitted with the compressed-air brake can work a train equipped with the vacuum brake.

## RAPID-ACTING VACUUM AUTOMATIC BRAKE.

TO convert the ordinary automatic arrangement of brake into a rapid action system several devices have been introduced. One form of valve is shown at Fig. 21, which is fitted on the upper side of the train-pipe as near as it can be conveniently placed to the brake cylinder, and connected to the release valve of the cylinder in the usual way, *i.e.*, by a flexible pipe.

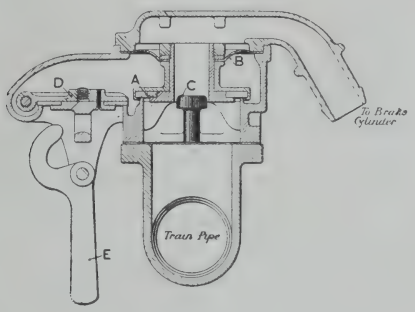



FIG. 21.

The normal or "running" position is shown by Fig. 21. The vacuum is maintained on the underside of the valve A, and at the top side of the diaphragm B, through the passage C, the atmospheric pressure being free to act through the clappet D between the valve A and the diaphragm B; on account of its excessive area the valve A is held tight to its seating.

When rapid action is required, and air is suddenly admitted to the train-pipe by the manipulation of the driver's valve, guard's valve, or by parting of the train, valve A lifts and air entering through the clappet D is allowed to pass full bore direct from the atmosphere to both the brake cylinder and the train-pipe. Immediately the brake is "full on" the valve falls to its normal position by its own weight.

To obtain a graduated application of the brake, air in moderate quantities is admitted to the train-pipe, and the area of the passage around the peg C is so proportioned that it will allow the necessary amount of air to enter the brake cylinder, and so tend to obtain simultaneous action of the brake on every vehicle throughout the train.

The clappet D performs three functions :—

1st It prevents dust accumulating in the valve casing, keeping it perfectly clean, as it always rests on its seat (except during an emergency application), see Fig. 21.

2nd. In case of a leakage, either in the diaphragm or seating, the clappet can be shut down by means of a lever E, and thus an air-tight brake insured until such time as the valve can be attended to.

3rd. It allows of the same apparatus being used either as a " RAPID-ACTING " or an " ORDINARY " vacuum automatic brake. In the former case the clappet valve is free to work, as shown in the drawing, and in the latter the valve is held upon its seat by means of the lever.

This " Rapid-acting " vacuum automatic brake is specially adapted for long passenger, goods and mineral traffic, for which it is specially recommended.

## RAPID ACTING VALVES OR "ACCELERATORS."

THE rapid-acting valve or "accelerator" is made in three forms—Types E and Q, as already described, which can be fitted on the train-pipe or on the syphon seating leading direct to the cylinders, and Type B, Fig. 23, which is intended to be fitted on the "swan neck," or elbow of the vertical portion of the train ppe. In this position it is well away from dust thrown up by the train, but it is not always convenient to have it high up, owing to vestibule doors, etc.

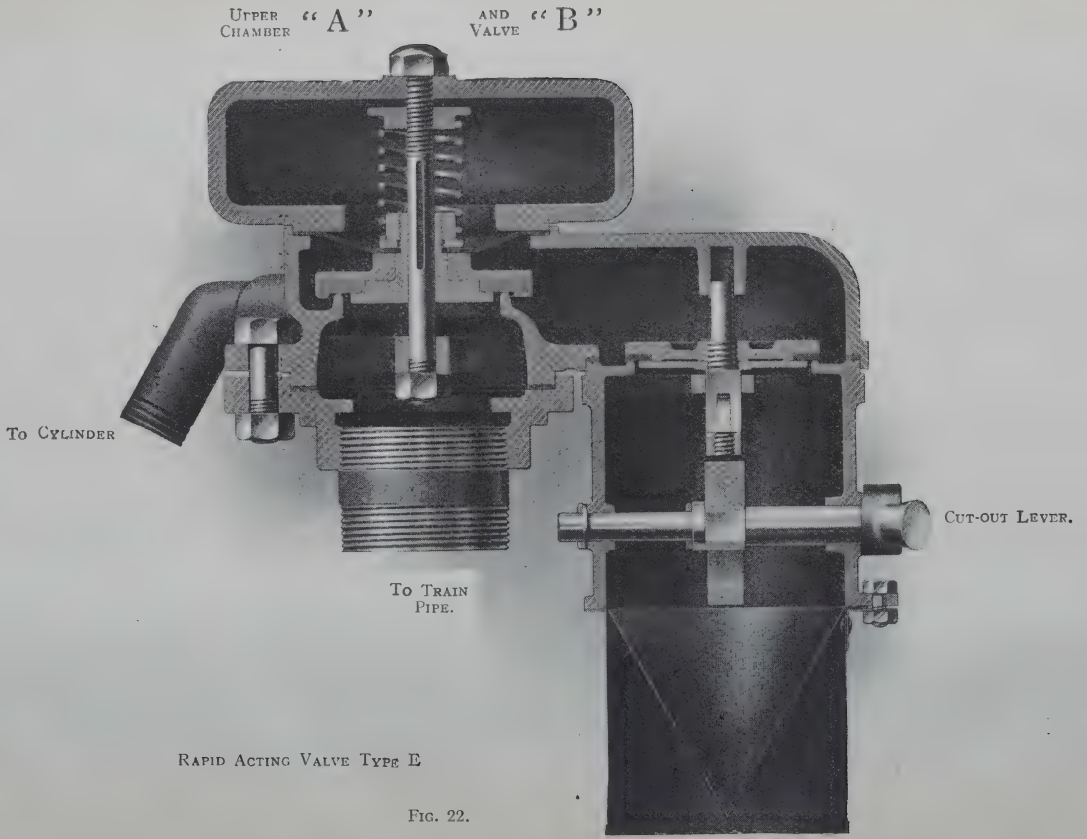
The sectional views of the two types show the construction clearly. Creation of vacuum in the train-pipes exhausts the upper chamber "A" by way of a groove in the valve spindle.

The valve "B" is kept closed by the combined action of the spring and the atmospheric pressure on the valve itself.

Upon an emergency application of the brake being made by admission of air to the train-pipe the valve "B" is lifted and additional air is therefore admitted, which rapidly destroys the remaining vacuum in the train-pipe and cylinder.

The valve closes automatically by the destruction of the vacuum in the upper chamber "A" which takes place by the leakage of air through a groove in the valve spindle, thus the lifting action of the atmosphere acting on the diaphragm is removed, and the valve closes under the action of the spring.

The type "Q" quick service valve has been introduced for equipping each vehicle of a train, a quick application of the brake is secured both in emergency and ordinary service applications. The device is so designed that when the driver opens his valve for a service application, which reduces the vacuum in the train pipe by a certain amount, the valve in the accelerator on the first vehicle automatically opens a communication to the atmosphere, which admits a certain amount of atmospheric




Rapid Acting Valve Type E

Fig. 22.

pressure, and this additional reduction of vacuum is sufficient to quickly communicate the same effect to the succeeding vehicle, and so on ; each accelerator in succession comes into action automatically throughout the train, and causes a very rapid transmission of change of pressure along the main conduit.

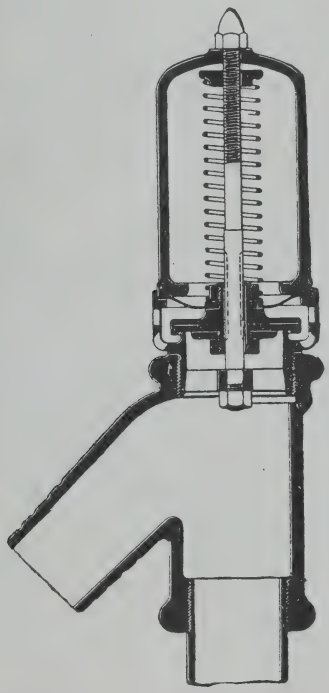


Fig. 23. TYPE B.

These valves are so constructed ,however, that they only remain open sufficiently long to allow the required reduction of vacuum to be passed on to the next valve in succession, when each in turn automatically opens, closing again after having admitted the requisite atmospheric pressure to partially apply the brakes with rapidity and regularity throughout.

If any further or increased brake power is required, a further reduction of vacuum by the driver again brings these accelerators into action, and this may be repeated until the vacuum in the main conduit is nearly destroyed. As these particular valves open and close in a definite period of time, they would not exert sufficient influence, in the case of an emergency application, to fully set the brakes, and they are, therefore, augmented by the more powerful emergency valve (Class "E"), which only opens on a sudden and large reduction of vacuum, produced by a sudden emergency application of the driver's valve, and remain open during a sufficiently long period to meet the necessary requirements.

It is stated with an ordinary service application of the brake, on a train of sixty vehicles, equal to 1,800 feet in length, travelling at forty miles per hour, all fitted with "accelerators," the time required to set the brakes was only three seconds, whereas with the same train without the "accelerators" the time taken was thirty seconds.

With the emergency application with same particulars as above, time required to set the brakes was only five and a half seconds against fifty seconds without "accelerators."

The following figures show the comparative length of time "with" and "without" accelerators that it takes for change of pressure to take effect on the 30th and 60th vehicle after the application of the driver's valve :—

| | 30th Vehicle. *seconds.* | 60th Vehicle. *seconds.* |
|---|---|---|
| Without accelerators emergency application ... | 6·5 | 14 |
| With do. do. ... | 1·75 | 2 |

The fittings of these accelerators on odd, or a few vehicles in a train only, will neither cause trouble nor objectionable results in working.

## CLAYTON-HARDY RAPID-ACTING VACUUM AUTOMATIC BRAKE.

THE most important users of the vacuum automatic brake on the Continent of Europe are the Austrian Railways, and in the standard equipment adopted thereon there are some divergencies in details from the standard used here which

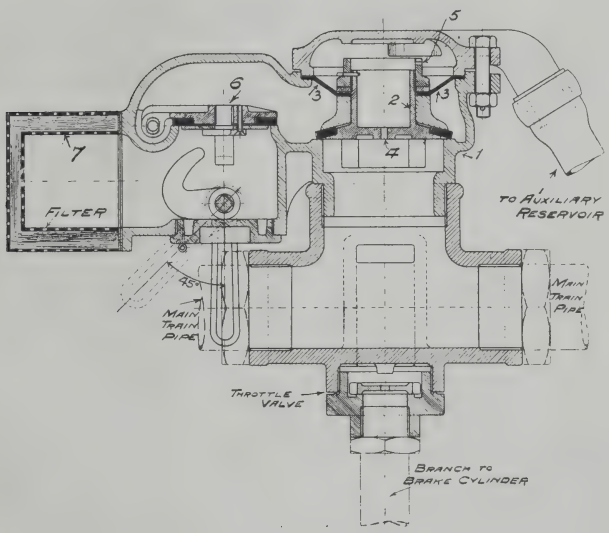



FIG. 24.

are interesting. The more particular items are the "quick-acting" and the "release" valves.

Fig. 24 illustrates the quick-acting valve in section. It consists of a case (1) with a seating on which rests a hollow valve (2), supported by a flexible diaphragm (3). The valve body possesses a larger annular seating at the bottom (4) than at the top (5), and the upper portion of the chamber

in which it operates is connected with a small auxiliary reservoir through the pipe shown. The flap valve (6) is provided as in the British pattern to admit air from the atmosphere for rapid action, and it can be locked down when required in the usual manner. An additional feature is the filter (7), through which air is drawn to operate the brake

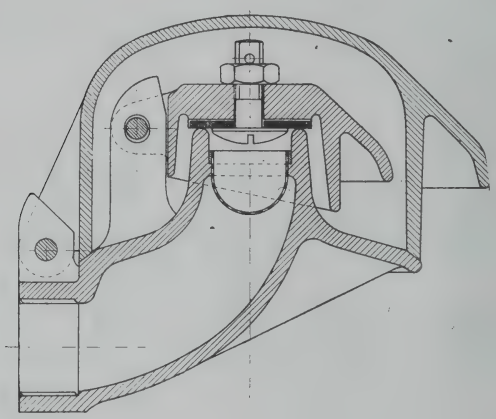


Fig. 25.

when valve (6) lifts. It will be noticed that the branch connection to the brake cylinder is made through a port at the side of the casting and not direct. A perforated metal washer is located at the neck to prevent too rapid an application of the brake on any one vehicle; this throttles the admission of air to each cylinder, and thus "jerky" action through a train is avoided.

Fig. 25 shows the "release" valve, which has an inclined flap-valve covered by a well-fitting cap. This is a good form of valve for its purpose, but two have to be provided for each vehicle (one on each side) as compared with the one central valve with chains or wires to operate it adopted in this country.

A sectional view of the brake cylinder is shown in Fig. 26, and the complete equipment for a passenger vehicle is given in Fig. 27, the references at the foot explaining the different parts.

As an instance of the rapidity of action of this arrangement of the vacuum automatic brake it has been found that on a train, the main train pipe of which measured 902 ft. long, the quick-acting valve of the last carriage commenced to work in one second after the brake was applied from the locomotive by the driver with a vacuum of $20\frac{1}{2}$-ins.

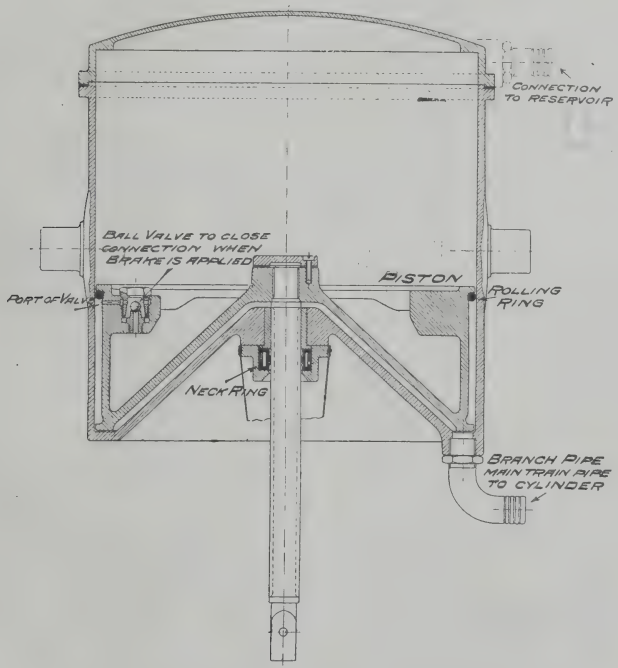
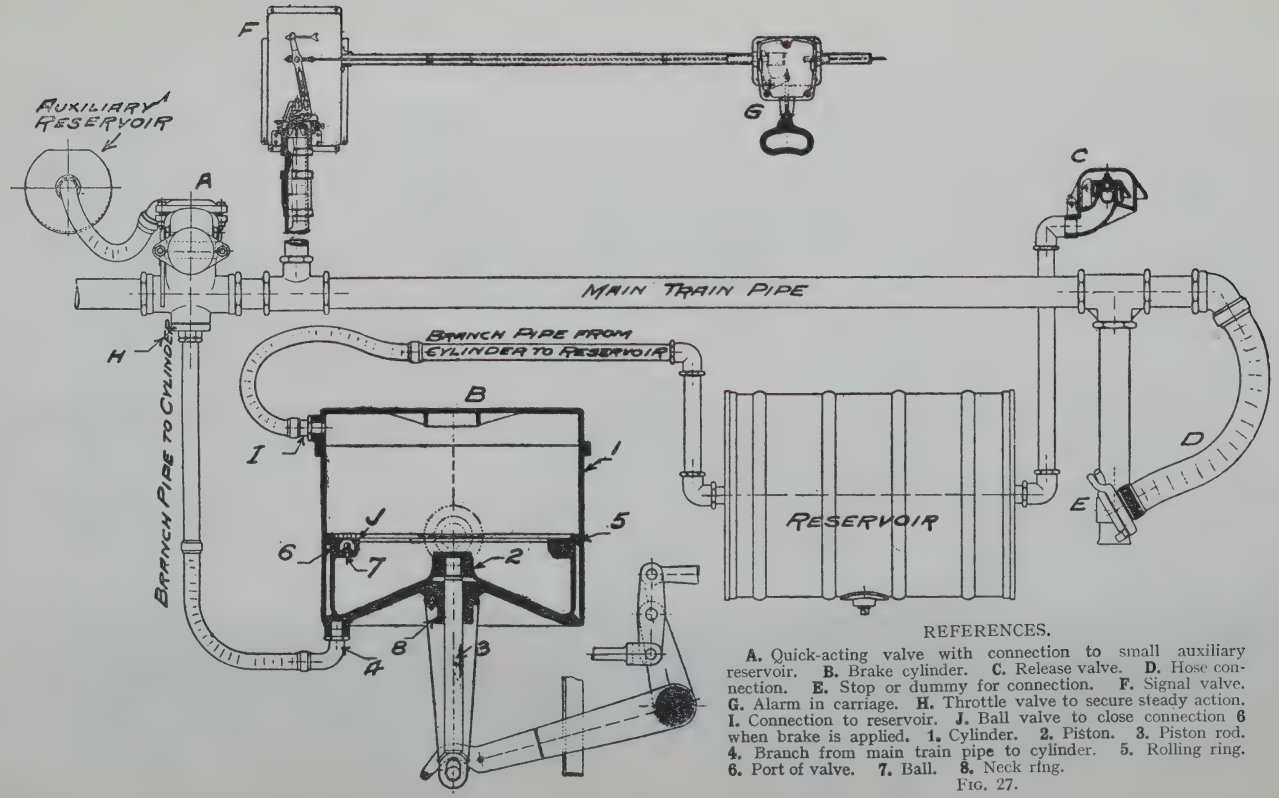



Fig. 26.

Trials with a goods train, consisting of 70 four-wheeled wagons and five four-wheeled carriages (for observation purposes) fitted with this form of brake, proved that the quick-acting valve on the




REFERENCES.

**A.** Quick-acting valve with connection to small auxiliary reservoir. **B.** Brake cylinder. **C.** Release valve. **D.** Hose connection. **E.** Stop or dummy for connection. **F.** Signal valve. **G.** Alarm in carriage. **H.** Throttle valve to secure steady action. **I.** Connection to reservoir. **J.** Ball valve to close connection **6** when brake is applied. **1.** Cylinder. **2.** Piston. **3.** Piston rod. **4.** Branch from main train pipe to cylinder. **5.** Rolling ring. **6.** Port of valve. **7.** Ball. **8.** Neck ring.

FIG. 27.

last vehicle began to act in $2\frac{3}{16}$ seconds from the time of application from the engine. The train pipe from the ejector to the dummy of the last vehicle measuring 2,632 ft. long, a rapidity of transmission of nearly 1,200 ft. per second was thus secured. The train weighed 1,196 tons, including the ten-coupled locomotive.

## "HIGH - SPEED" VACUUM AUTOMATIC BRAKE.

THE high-speed vacuum automatic brake has been working both in this country, on the Continent and in India for some considerable time past.

Stops made with this brake have been at least 25% quicker than with the ordinary automatic brake.

It has been found with trains travelling at a high rate of speed that the pressure of the brake blocks on the wheels may be anything between 100 and 120% of the pressure between the wheels and the rails at the time of the application of the brake; it is, therefore, necessary that the brake block pressure should be eased off automatically as the speed of the train decreases.

The Vacuum Brake Company introduced the arrangement illustrated in Fig. 28, which diagram shows the complete apparatus including the rapid-acting valve for a carriage. A high vacuum of 22 ins. or 24 ins. is recommended for this arrangement. The details of the apparatus are as follows:—

The brake cylinder does not differ materially from the one in general use except it is of larger diameter, *viz.*, 21 ins. for heavy vehicles.

A "High-speed ball valve" is bolted on to the bottom of the brake cylinder (in position occupied by release valve).

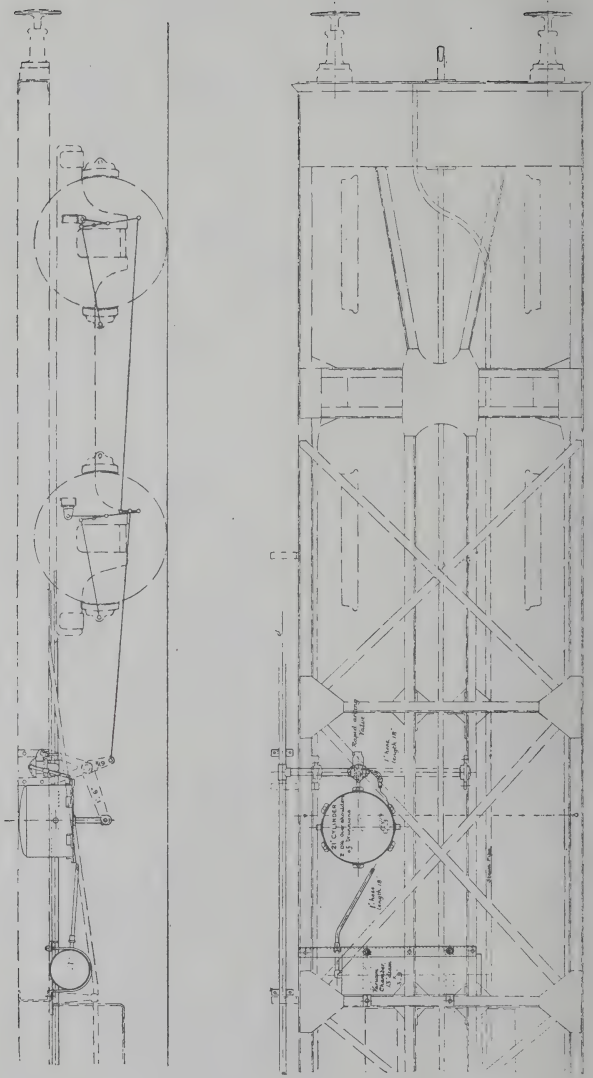


FIG. 28.

Fig. 29 is a section of this valve in the " running position." The large passage in the valve casing is in communication with the bottom of the cylinder and the train-pipe ; the small passage is connected with the top of the cylinder and vacuum chamber. The underside of the diaphragm shown at the bottom of the valve is in connection with the atmosphere through the holes provided in same.

When an application of the brake is made, air enters the large passage on its way to the other side of the brake cylinder piston, and also slowly finds its way into the vacuum chamber through the annular passage provided and the small holes in the stem of the valve.

When the vacuum in the vacuum chamber and on the top of the diaphragm has been reduced by a predetermined amount, the spring asserts its power and causes the hollow spindle beneath the ball to descend. This movement allows this ball to rest on its fixed seating and prevents any further reduction of vacuum in the chamber and space above the piston.

The period of leakage is governed by the size of the holes provided in the hollow spindle, and the spring working in conjunction with the diaphragm arrests this leakage at any desired amount.

It will be seen, therefore, that when an emergency application is made full power will be exerted by the piston in the brake cylinder, and that this power is gradually reduced as the train comes to rest.

In case of emergency an instantaneous application of the brakes on the train is obtained by means of the rapid-acting valve placed on the train pipe and shown at Fig. 21.

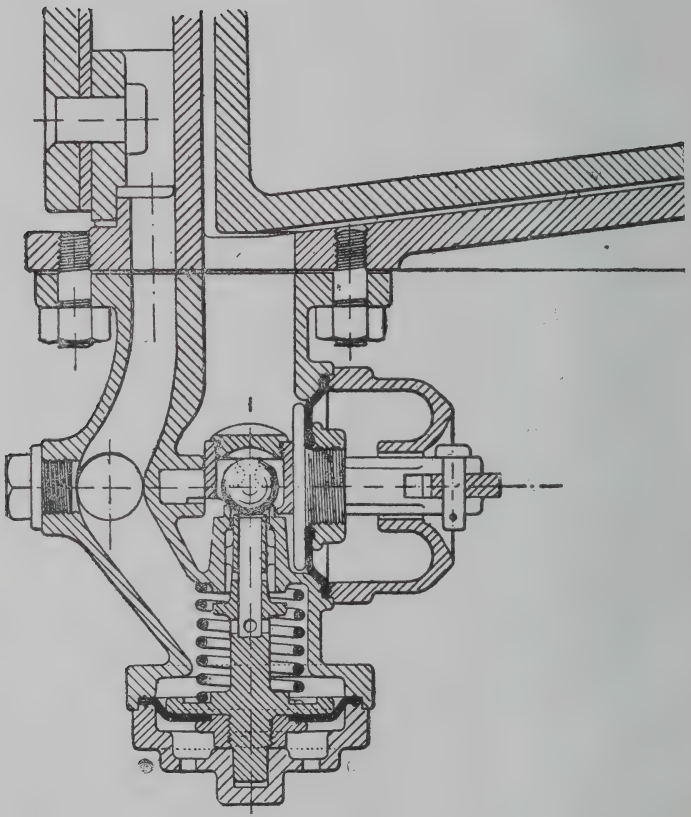


Fig. 29.

## POSITIVE "LOAD" VACUUM BRAKE EQUIPMENT.

FROM the early days of continuous automatic brakes on railway wagons, schemes have been devised and trials made in the endeavour to automatically adjust the range of brake power on each individual wagon according to the "load." The arrangement, as shown in Fig. 29A, has been introduced by the Vacuum Brake Company.

Fig. 29B shows the general arrangement of a four-wheeled wagon taring about 10 tons and intended to carry a load of 22 tons, details of the brake apparatus being shown.

"A" is an ordinary 18-inch combined cylinder, to provide the brake power when the wagon is running empty.

"B" is a 24-inch cylinder with its chamber "C" to provide the additional brake power required to compensate for the load when it is intentionally put into service by operation of special valve "D". Both these cylinders are connected up to a common brake shaft "E", and as the piston rods have free ends where they take on to the forked levers of the shaft, one or both can exert its pull without derangement. The special valve "D" is operated by hand from either side of the vehicle, to open the communication to the large cylinder, but it will automatically close when the vehicle has been detached from its train after a fixed interval.

Details of the valve are shown in section, Fig. 29A. It consists of a case, "A," in which valve "B" is located, the valve is mounted on a spindle, "C", which has also two diaphragms "D" and "E" attached to it; the spindle has a slotted centre part through which rod "F" can freely pass. Adjacent to the spindle or valve stem "C" is a second one, "G", which carries a diaphragm, "H," and this spindle has a similar slotted aperture for the rod "F" to pass through. The upper part of the casing is connected up to the vacuum chamber

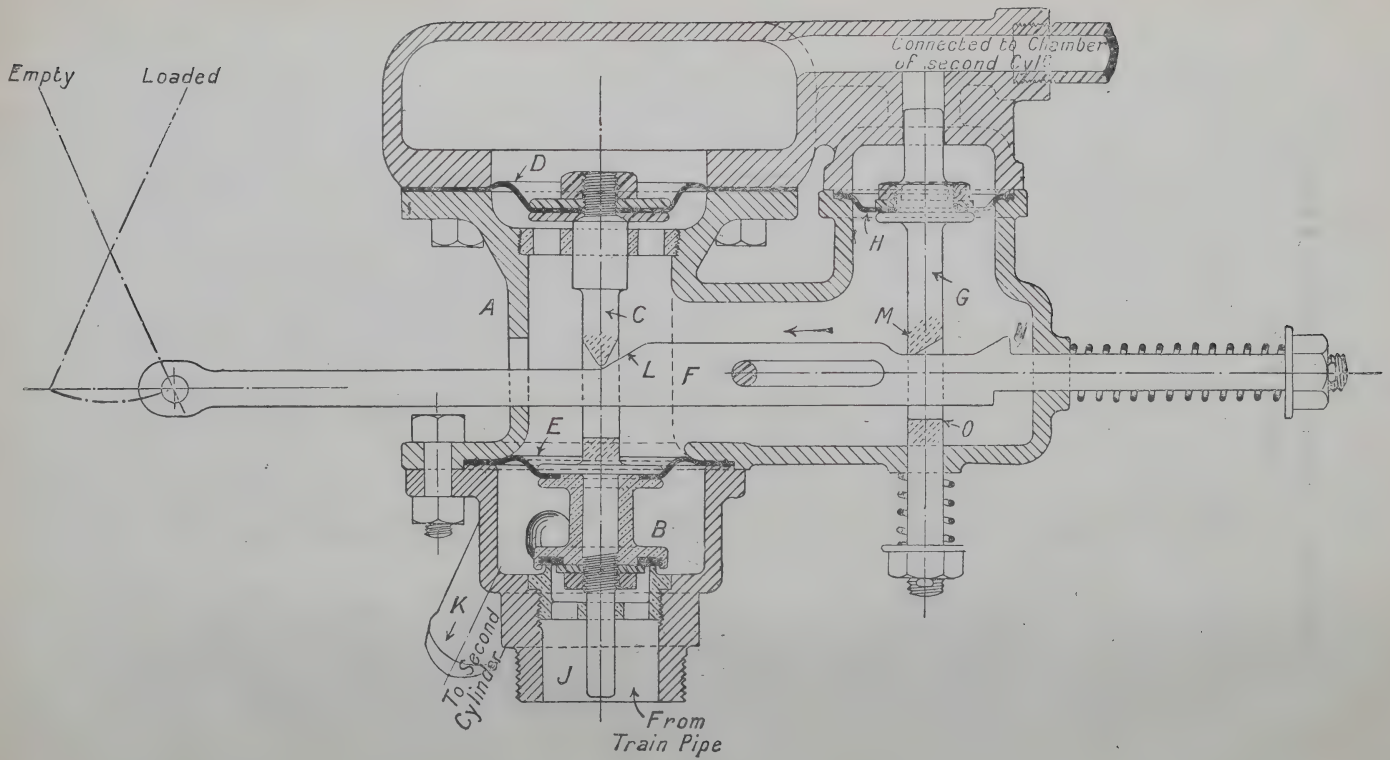

Empty
Loaded
Connected to Chamber of second Cyl.
D
H
A
C
G
M
N
L
F
E
O
B
K
To Second Cylinder
J
From Train Pipe

FIG 29A.

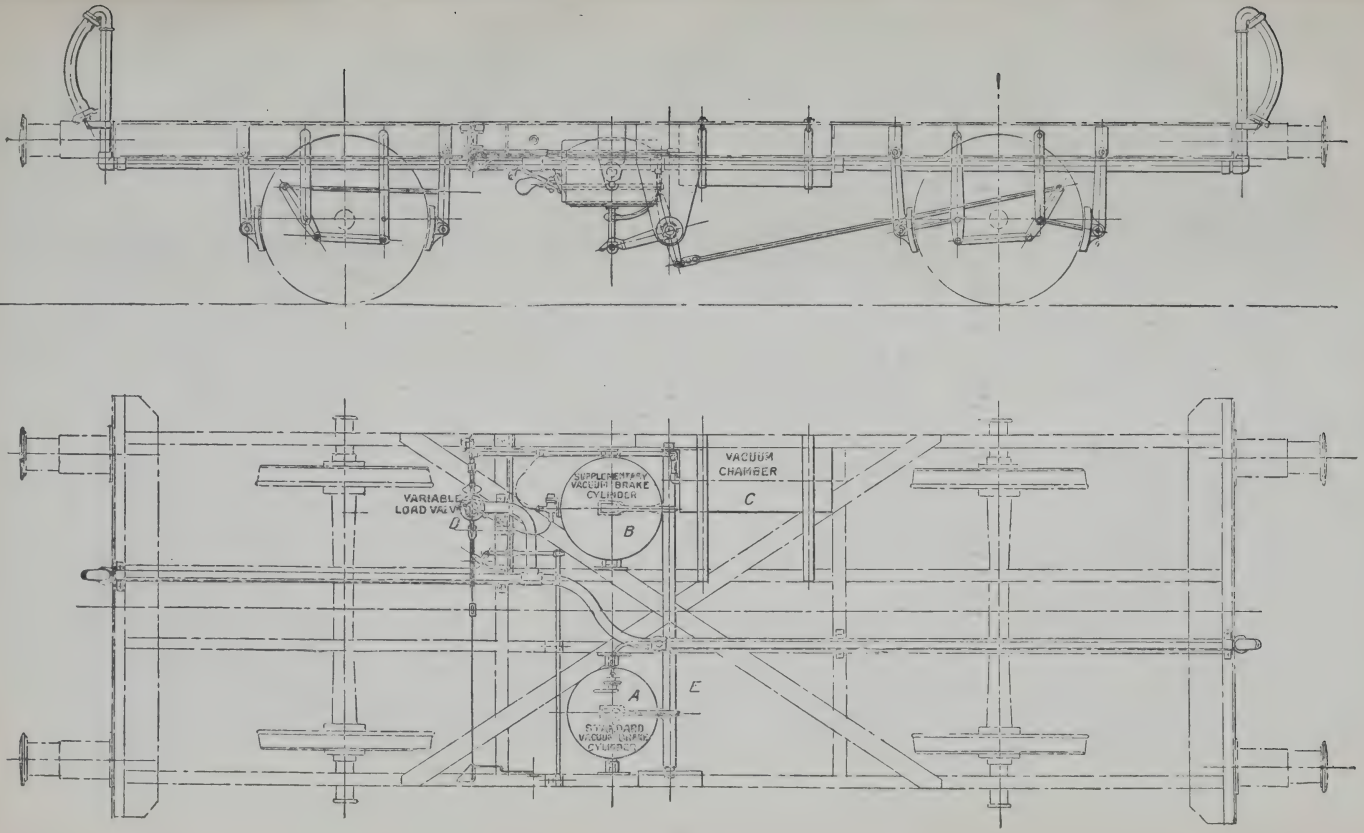

VARIABLE LOAD VALVE
SUPPLEMENTARY VACUUM BRAKE CYLINDER
B
VACUUM CHAMBER
C
A
E
STANDARD VACUUM BRAKE CYLINDER

FIG. 29B.

of the second or "load" and large brake cylinder; the valve "B" intercepts the connection between the main train pipe "J" and the branch "K," which leads to the second brake cylinder and its chamber; the springs on the spindle "G", and rod "F", are intended to bring those parts back to normal when the valve and its "lock" are no longer under the influence of vacuum.

### THE OPERATION OF THE "LOAD" VALVE.

When it is desired to put the second cylinder into operation on a loaded wagon, the rod "F" is pulled over by manipulating the lever provided on both sides of the wagon. As "F" moves in the direction of the arrow, the incline "L" will lift the spindle "C", and with it the valve "B", establishing connection through the branch from the train pipe to the second or additional brake cylinder; the movement of the rod "F" has also lifted the spindle "G" in similar manner, while the tooth "M" falls behind the notch "N" holding the rod "F" in the extreme position it has been pulled to. If now vacuum be created in the train pipe the second or "load" cylinder will also be exhausted through the branch opened by the valve "B". As the upper part of the valve chamber "A" is in connection with the chamber of the second cylinder, this will also be subjected to vacuum with the result that the diaphragm "D" will be held up by the pressure of the atmosphere below it, and with it the valve "B." The diaphragm "H" will also be affected, and it will lift the spindle "G" releasing the tooth "M" from behind the notch "N", but bringing up the face "O" to the level of the underside of the rod "F" to move to the right until it is stopped by the tooth. It will be held in this position so long as vacuum is maintained in the upper part of the valve casing and the chamber of the second cylinder. Both cylinders of the brake apparatus are now in opera-

tion, and a braking effect secured in suitable proportion to the gross weight of the wagon.

As long as an engine is attached to the train and vacuum maintained, the apparatus will remain as "set." In fact, it will continue to be so until the vacuum in the chamber of the second cylinder is destroyed by "leaking off" or intentional release. When this latter condition occurs, the spindle "G," with its stop "O," will fall by gravity, permitting the spring to throw the rod "F" back to its normal or "empty" position. The spindle "C" and valve "B" will also fall and close the communication from the main train pipe to the second or "load" cylinder. The "load" brake cylinder will not operate the brakes until such time as additional power is again required, when the valve must be reset by hand.

## HOSE-COUPLINGS, DUMMY PLUGS. TRAIN-PIPE, &c.

THE hose-couplings attached to the train pipe at the end of each vehicle require attention and care. They are of various lengths to suit special circumstances, generally from 22-in. to 27-in. They are made of a mixture of rubber and canvas cloth, wired at intervals of one inch, inside and out, to give stability. It is seldom that leakage is found in the hose-pipe itself, but generally at thejoint of the hose and coupling casting or at the top, where the clip secures it to the bend or "swan-neck" of the train pipe. The bends are usually made of cast iron or brass and are screwed to the top of the train pipe.

Sometimes the hose pipe is found very stiff and not as pliable as it should be, due, no doubt, to the rubber mixture in the hose-coupling losing its durability from want of use; rubber, as a rule, lasts longer when in continual service. A cure for this stiffness is to wet the hose in hot water.

The coupling heads or ends which form the connection between two carriages are two castings exactly alike, having horns at the bottom and lugs and

slots at the top. These castings may be either of cast or malleable iron, the latter being stronger and more durable; they are strongly wired on to the hose pipe.

Breakages of these couplings are not frequent, they being strong enough to stand ordinary wear and tear for some time. They should not be left to swing loose when uncoupled, but placed on the dummy plugs.

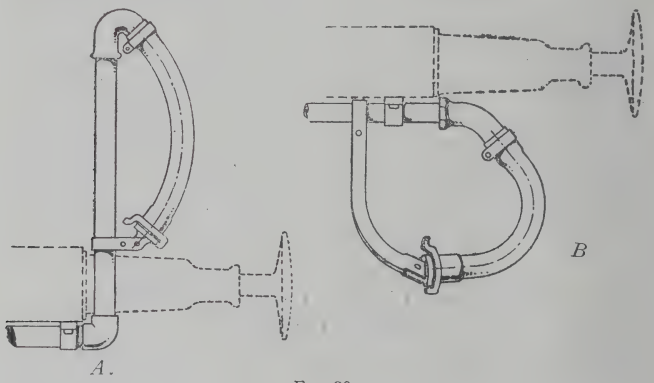



Fig. 30.

On British and Continental railways using the vacuum automatic brake the dummy plug is fixed to the train pipe just above the bend (about 12 in.), coming from under the body of the carriage, as shown at A, Fig. 30. It is made of cast iron, secured to a wrought iron band passing around the train-pipe. Its use, as already explained, is for the retention of the flexible hose-couplings when they are not in use, or form the end of the train-pipe. On the Indian and some other railways the hose is arranged differently, as shown at B, Fig. 30, and in this case the plugs must have " horns " corresponding with the couplings to secure the hosepipe from falling off, as there is no tendency to " spring " the pipe on as in the British pattern of coupling.

Grease should not be allowed to get on the plugs, and they should be kept clean so that no dirt clinging to them may get " sucked " into the train pipe when a vacuum is created. Small particles of dirt

accumulate very quickly, and often lead to trouble in the working parts of the brake. Regular inspection of the couplings is desirable.

The couplings are rendered airtight by rubber washers and continuity of vacuum throughout the train-pipe can only be secured by all hosepipe connections between engine and vehicles being properly coupled up and the pipe at the rear of the train being correctly placed upon the plug provided for this purpose.

In coupling and uncoupling care must be taken that the rubber washers are not displaced or lost.

The vacuum in the train-pipe must be destroyed before vehicles are uncoupled ; neglect of this precaution leads to the washers being torn from the grooved recesses which retain them. To couple the hosepipes they must be taken one in each hand and lifted sufficiently high to hook the bottom horns of the couplings together first, and then when lowered the top horns of the couplings will fall in the slots.

To uncouple the hosepipes they must be lifted straight up, when the horns at the top will come out of the slots and the couplings will separate.

**TESTING THE BRAKE APPARATUS FOR LEAKAGE.**

To test for leakage, first create vacuum, then shut off the ejectors and note if the gauge needle falls ; if tight and correct, apply the brakes. If the vacuum reservoir finger drops to zero instead of remaining between 10 and 15 ins., the leakage may be due to the following causes : Dirt in the cylinder release or ball valve, damaged rolling ring, or leakage in the pipes leading to the reservoir. If the brake does not leak after application but does before, examine the drip valves, piston rod bush, application valve, train pipe, and pipes to the bottom side of the cylinder.

When making an examination for a leak a ready means of detecting it is to apply a piece of lighted tar band, or other flame, to the suspected fault, and the suction will draw the flame.

## AUTOMATIC STEAM BRAKE VALVE.

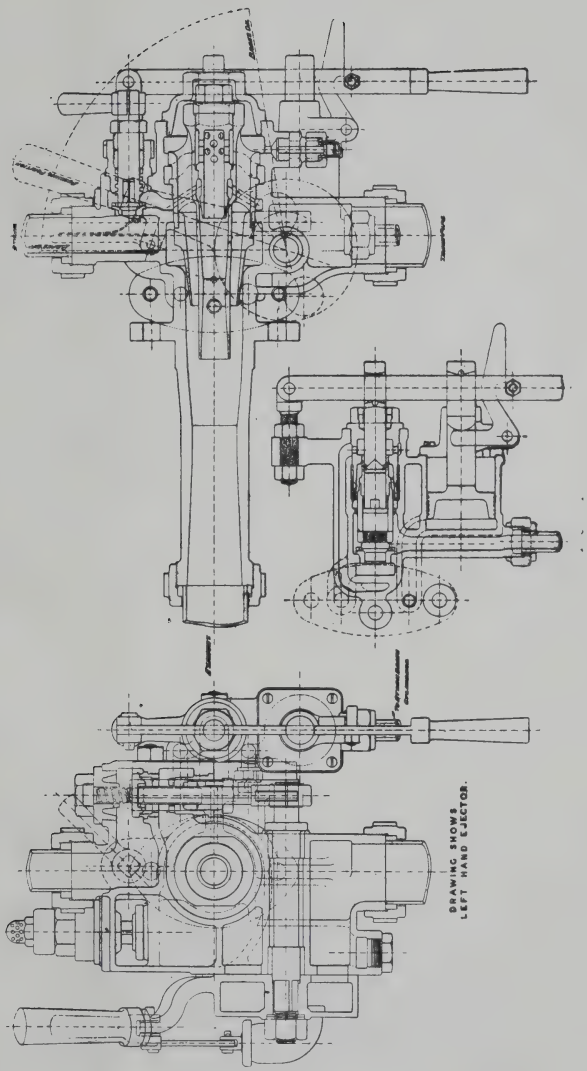
THIS valve, which is shown at Fig. 31, is designed for use in conjunction with the vacuum automatic brake when the engine or engine and tender is fitted with a steam brake, and its object is to apply the steam brake on the engine at the same time as the vacuum brake is applied on the train.

Its automatic action depends upon the vacuum brake, and is as follows:—When a vacuum is created in the train pipe, the chamber on the inner side of the vacuum piston is also exhausted, through the port; this causes the piston to move inwards, as it is affected by the pressure of the atmosphere on its outer side, and by means of the lever it forces down the steam piston upon its seat and shuts off the supply of steam. The valve is now in the "off" or running position, as shown in the diagram.

When the vacuum brake is applied by the admission of air to the train pipe, air is also admitted to the chamber—not by the port, which is immediately sealed by the action of the incoming air on the ball, but through the small feeding hole, and, the pressure on either side of the vacuum piston being gradually equalized, a point is reached when it can no longer resist the counter pressure of the steam piston; the latter is forced outwards and steam admitted by the passage to the steam brake cylinder, to operate and apply the brake.

The release of the steam brake takes place automatically, and is controlled by the vacuum brake, the re-creation of a vacuum in the train pipe again exhausting the chamber, the action first described is repeated, and steam shut off. The steam left in the brake cylinder and the connections therefrom passes through an exhaust port and a second passage, which is in communication with the exhaust barrel of the combination ejector by means of a hole provided for it.

It may be noticed from the drawing that the piston is so formed that steam is prevented from


DRAWING SHOWS
LEFT HAND EJECTOR.

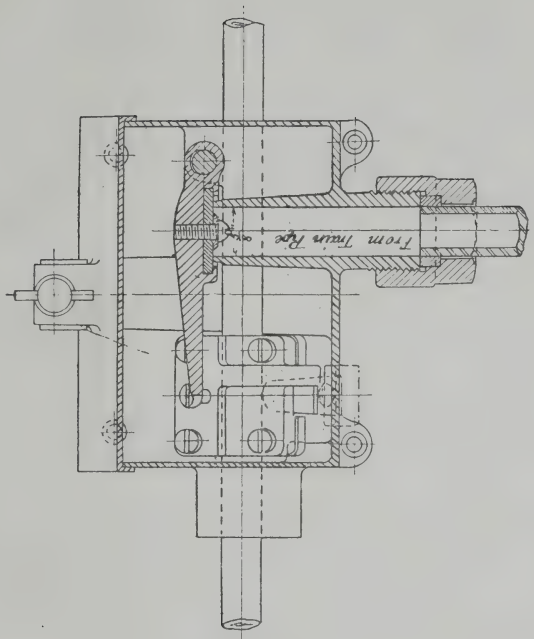
passing to the brake cylinder until the exhaust port is shut off, and that at the same time as the steam passes to the cylinder it reaches the top of the piston, the effective area of which is equal to that of one end, thus putting the complete piston in equilibrium, after which its movement is controlled by the varying amount of vacuum in the train pipe and the chamber, acting in similar manner to a reducing valve, gives an application of the steam brake proportional to that made by the vacuum brake.

A diagonal hole prevents pressure accumulating on the side of the piston from leakage, which would disturb its equilibrium.

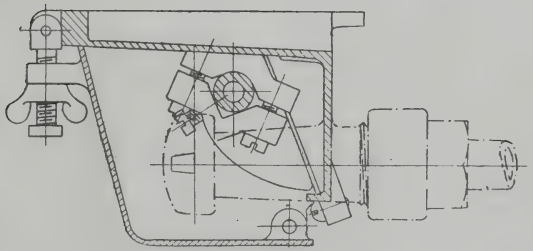
When the ejector is closed the steam valve is kept shut by a trigger being hooked over a pin. It is so arranged that it is impossible to hold this lever when the vacuum is created in the chamber already referred to, for it will be observed that the action of hooking the lever pulls out the piston through the medium of a catch; on a vacuum being created the piston is forced back, and, pressing upon the catch, unhooks the trigger and leaves the lever free.

## PASSENGERS' COMMUNICATION AND ALARM SIGNAL APPARATUS.

FIG 31A shows the valve-box of this apparatus fitted in the centre and nearly at the top of one end of a carriage. Connection with the vacuum brake apparatus is made from the top of the bend of the train-pipe and at one end of the carriage by means of a $\frac{3}{4}''$ pipe. This pipe, like the brake train-pipe, is exhausted; the end of it terminates in the valve-box with a $\frac{5}{8}''$ nozzle, over which fits a leather cap secured to the metal flap working on a spindle and passing through the valve-box. This spindle is fixed to cranks enclosed in a suitable case at each side of the carriage, which, in their




31 A.

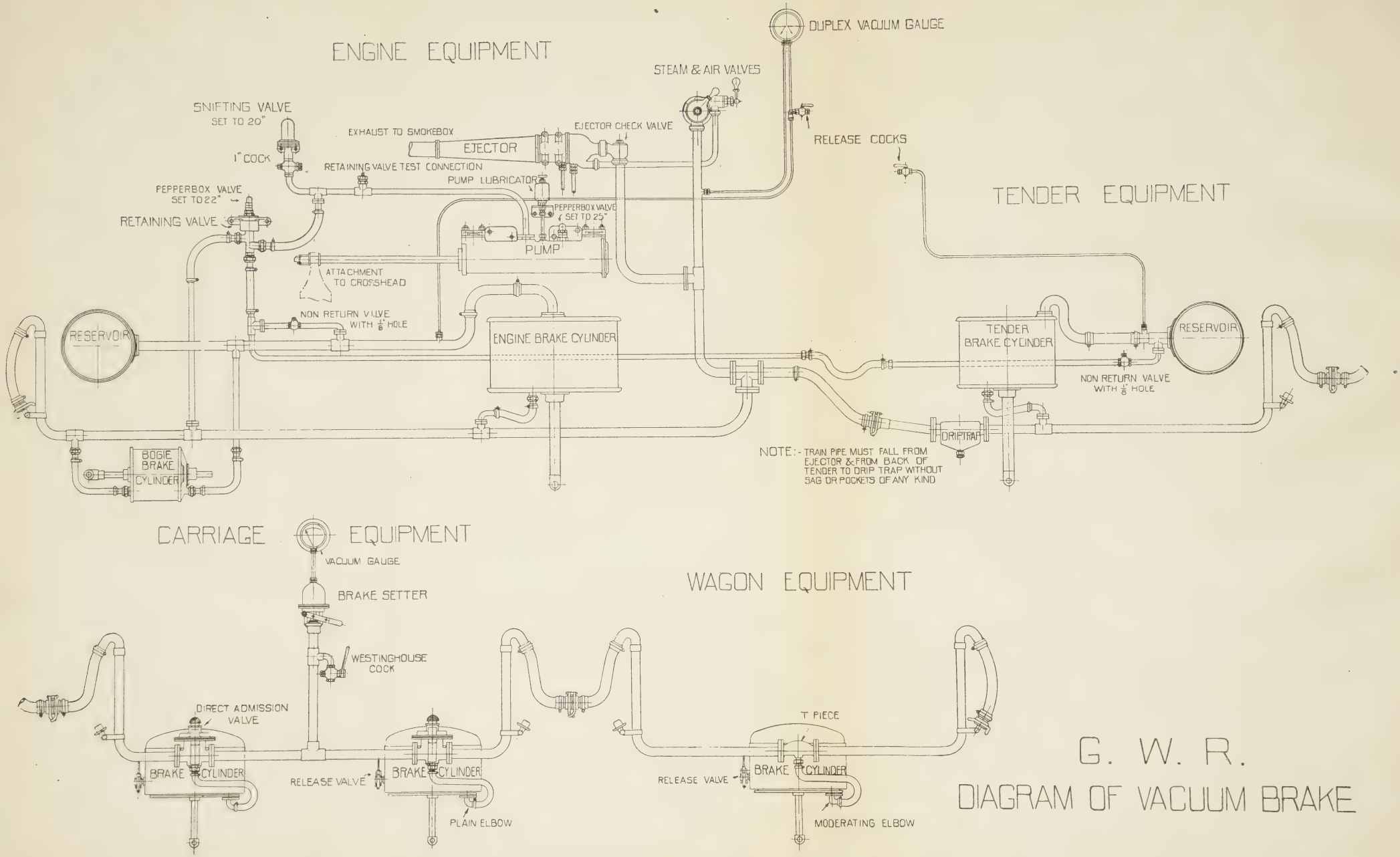


turn, are secured to the chains passing along the cornice in each compartment. The chain is made tight by means of an adjustable nut and screw fixed to the opposite end of the carriage to that on which the cranks are fixed.

The chain, on being pulled down from its normal position, operates the cranks and discs attached to the spindle passing through the valve-box, the spindle on revolving causes the flap to come away from the nozzle of the auxiliary pipe leading from the train-pipe, and the discs to revolve into a vertical position, the latter showing the guards at once from which carriage the alarm has been given. The flap on coming away from the nozzle in the valve-box allows air to enter the train-pipe; the vacuum is consequently partially destroyed, and the brake applied to a sufficient extent to warn both guards and engineman that an alarm has been used.

If the alarm has been raised at some very inconvenient part of the journey, such as in a tunnel, the engineman would keep the brakes partially off by opening the large ejector sufficient to prevent the train from being brought to a standstill, and proceed until a convenient stopping place be reached. If the alarm has been raised near a station at which the train was not booked to stop, it might be brought to a standstill there, but the engineman generally uses his own discretion as to what he should do, but the instructions issued are to the effect "that he is to as speedily as he can bring the train to a standstill at some convenient place, and to remain in such a position until the guards notify him that he may proceed."

To return the flap in the valve-box to its normal position, the disc is turned from the vertical to the horizontal and normal position, enabling vacuum to be re-created and maintained. A good plan is to provide the spindle acting on the cranks and discs with a chain and handle hanging down at the end corner of the carriage, thus enabling the




# G. W. R.

# DIAGRAM OF VACUUM BRAKE

FIG. 32.

*To face page 75.*

guard to restore the discs to their normal position without mounting the footboards for the purpose.

If in working this alarm signal it is found to have little effect when an excessive vacuum is being maintained the best way to overcome the fault is to enlarge the nozzle of the auxiliary pipe, thus giving a larger opening for air to enter.

It is as well to test the alarm signal from time to time to insure its being in proper working condition; to do this, the brakes on the train must be "off" and not "on," and the engineman and guards, on observing their respective vacuum gauges, can at once see whether any effect has been made. These tests can be carried out before setting out on the journey, by one of the guards entering a compartment and pulling down the chain. The vacuum registered on the dial of the gauges should be considerably reduced as soon as the flap has been withdrawn from its seating in the valve-box.

Experiments have been made in painting the discs of the alarm signal with a luminous paint so as to enable the guards to see from which carriage the alarm has been raised at night.

## VACUUM AUTOMATIC BRAKE ON THE GREAT WESTERN RAILWAY (England).

THE Great Western Railway have adopted a modified form of vacuum brake. Fig. 32 shows the general arrangement of equipment on the engines, tenders, carriages and waggons.

The steam and air valves are placed in the cab, but the ejector (1) Fig. 32A, is outside on the right hand side of the fire box, the exhaust pipe (2) from which passes along the outside of the boiler to the smoke-box, an air pump is used to maintain the vacuum while running, the piston rod being attached to the crosshead.

It will be seen from Fig. 32 two brake cylinders are used on the engine, a separate one for the bogie

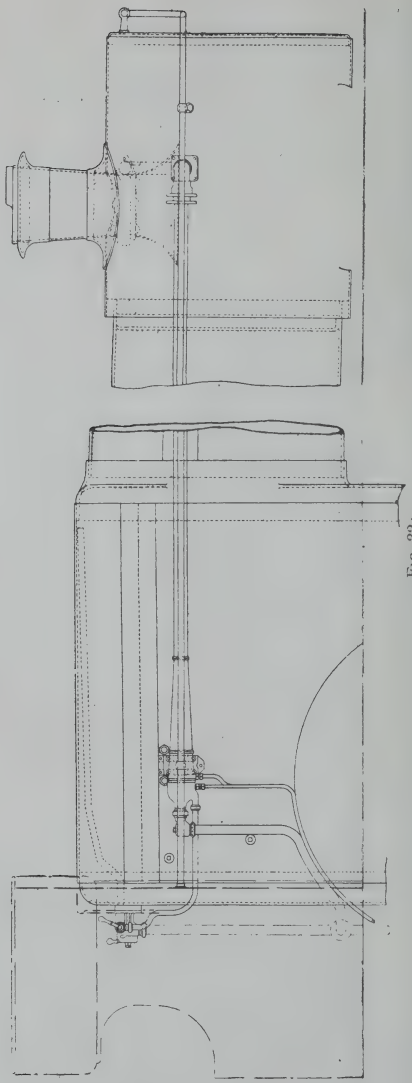


FIG. 32A.

The " snifting " valve is used on engines working vacuum goods trains only. The brake cylinders, Fig. 32b, on the carriages and wagons are of the " combined " type with release valves attached.

It will be noticed from the figure that no rolling ring is used, an indiarubber band round the piston takes its place. Six holes are provided in the piston head ; these form the necessary connection between the top of the cylinder or vacuum chamber and the under-side of the piston. When vacuum is created, the vacuum chamber is exhausted through these holes, past the rubber band.

The pump employed on the G.W.R. for working and maintaining the vacuum has been previously illustrated and described.

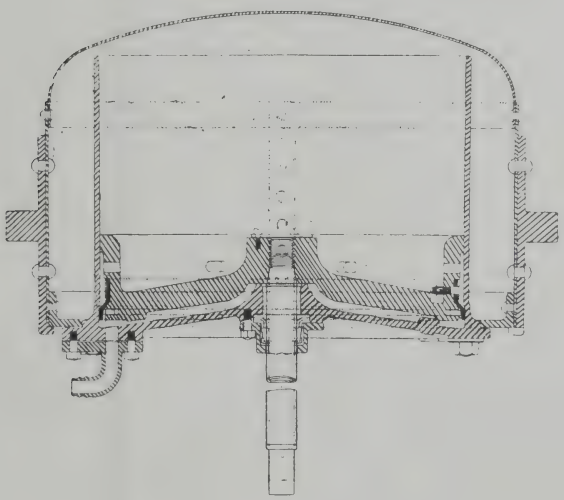
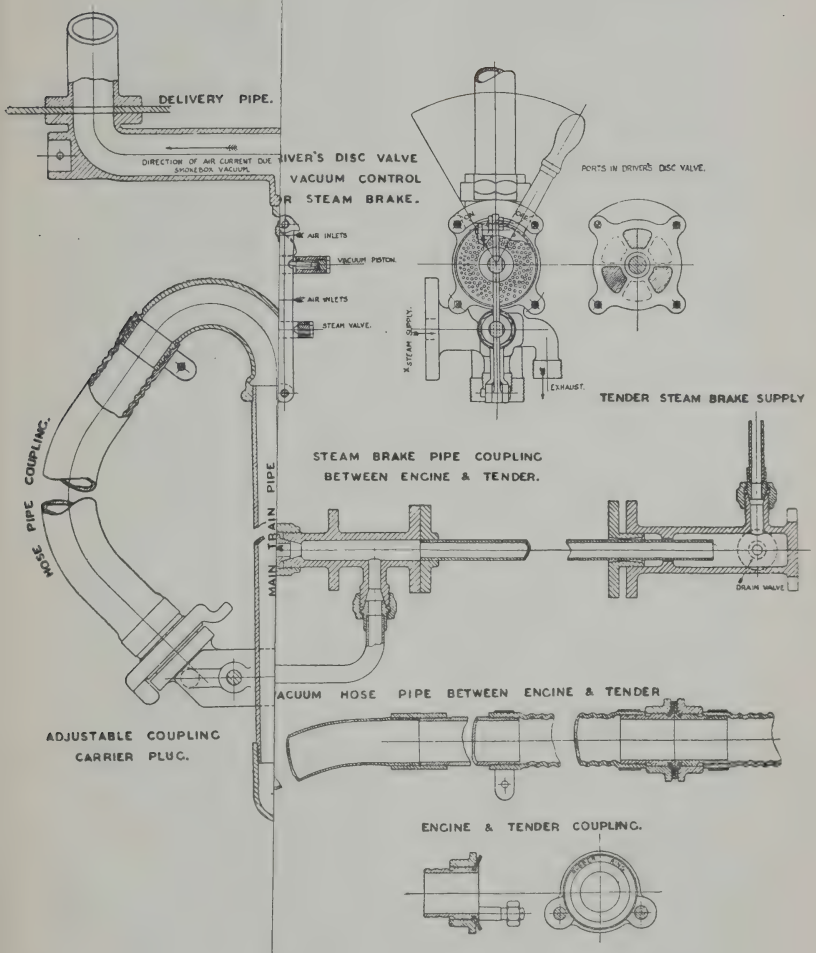


Fig. 32b.

## VACUUM AUTOMATIC BRAKE ON THE MIDLAND RAILWAY (England).

THE Midland Railway has an automatic steam and vacuum brake of particular design, so far as the ejector and driver's application valve are concerned. Fig. 33 shows the complete arrangement of this equipment on the engine, including the ejector driver's disc valve and vacuum control for steam brake, and engine steam brake cylinder, together with the pipe connections. All the other fittings are standard type. Driver's application handle has two positions, " on " and " off." In the diagram it is shown in the " off " position.

Dealing with the operation of the driver's disc valve the vacuum piston is subjected to the exhaust action of the ejector, and is kept in the position shown by the pressure of air behind it, this is admitted by grooves in the stem of the valve. The brake is operated by moving the application handle from right to left, thus admitting air in the train to pipe through the disc valve, of which the front elevation is illustrated, also the ports. When the operating handle is moved, the steam brake is also applied on the engine and tender through the medium of the vacuum piston, and steam valve which are both attached by means of a lever. The vacuum in front of the piston is destroyed by the air in the train pipe reaching the front chamber, and thereby moves outwards at the same time, causing the connecting lever to move and open the steam valve. When it is desired to release the brakes, a vacuum is created by exhausting air from the front of the vacuum piston, and the pressure of atmosphere acts upon the piston which forces it inwards, and so, by means of the connecting lever, closes the steam valve. Exhaust steam from the brake cylinders on engine and tender is conducted away by means of a pipe at the back of the steam valve to the atmosphere.

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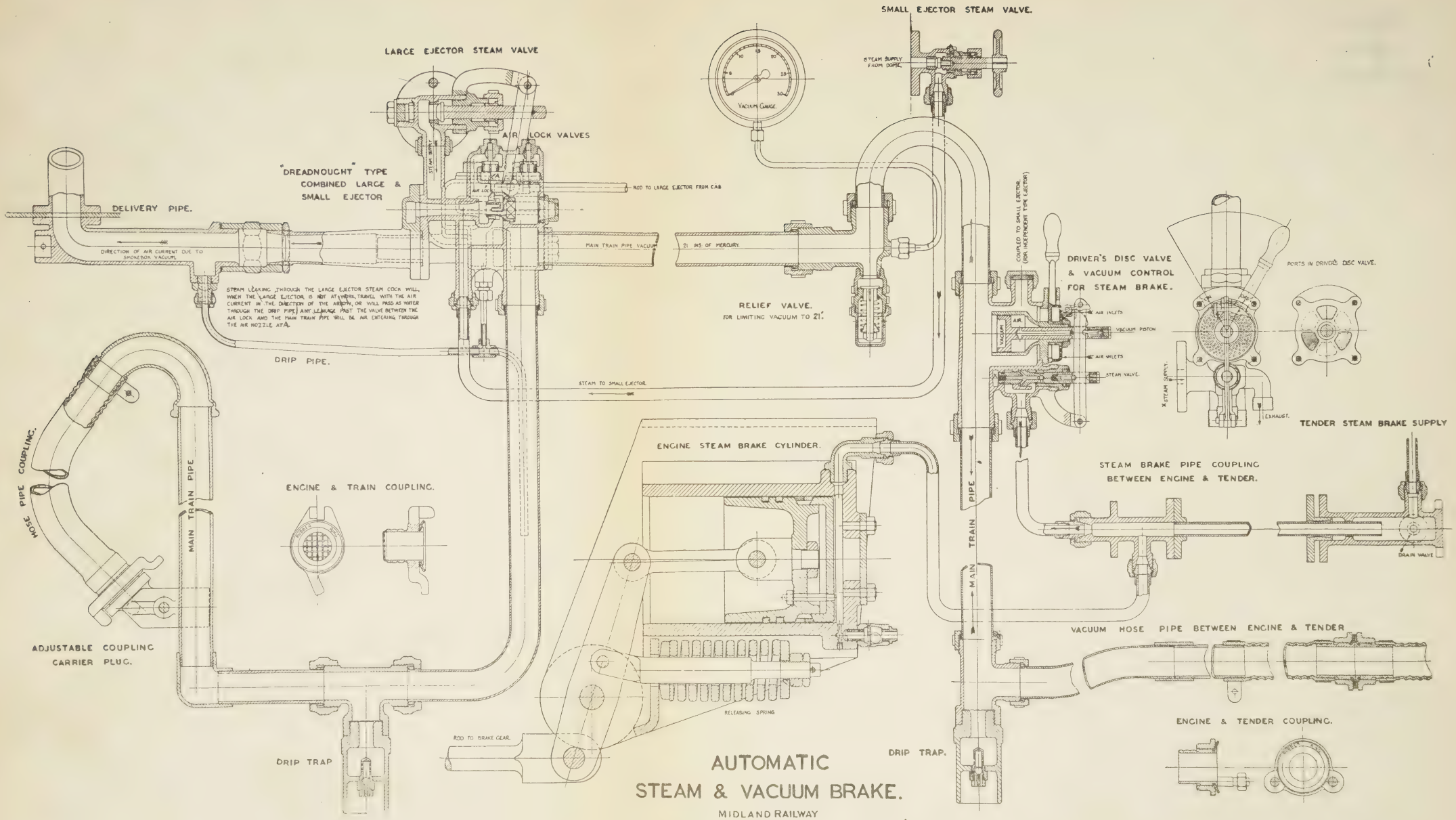



# AUTOMATIC STEAM & VACUUM BRAKE.

MIDLAND RAILWAY

FIG: 33

*To face page 78.*

The combined large and small ejector "Dreadnought" type is placed on the right-hand side of the boiler near the smoke box end, and is operated from the cab by means of a rod, which, when it is required to operate the ejector is pulled, thus opening the large ejector steam valve. Any steam leaking through the large ejector steam cock will, when the large ejector is not at work, travel with the air current in the direction of the arrow, or will pass as water through the drip pipe. Any leakage past the valve between the air lock and the main train pipe will be air entering through the air nozzle at A.

On the main train pipe a relief valve is fixed to limit the vacuum to 21 inches. The valve seating is kept in position by means of the spring as shown, and in the event of an excess vacuum in the train pipe above 21 inches, this valve will lift, and so automatically control the vacuum.

## LONDON AND NORTH-WESTERN VACUUM AUTOMATIC BRAKE.

THE London and North-Western Railway have adopted "sacks" of the diaphragm type, Fig. 34, one on the engine and one on the tender, a reservoir also being carried on the latter for retaining a reserve of power to both mentioned "sacks."

The vacuum is created by an ejector and maintained when the engine is running by a pump.

When the brake is applied a valve automatically cuts the pump off the "train" side pipe and throws

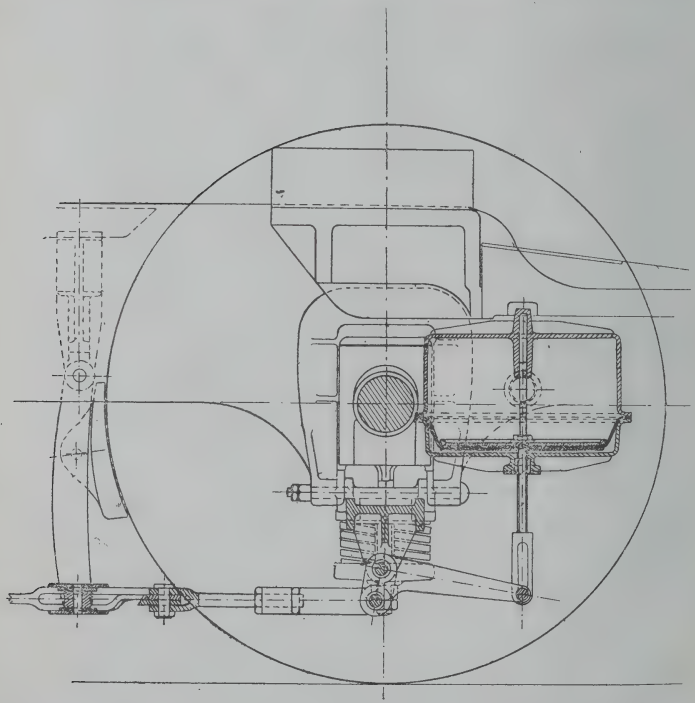


FIG. 34.

it over to the "sack" and "reservoir" side of engines, thereby maintaining a good reserve of brake power until the engine is brought to rest.

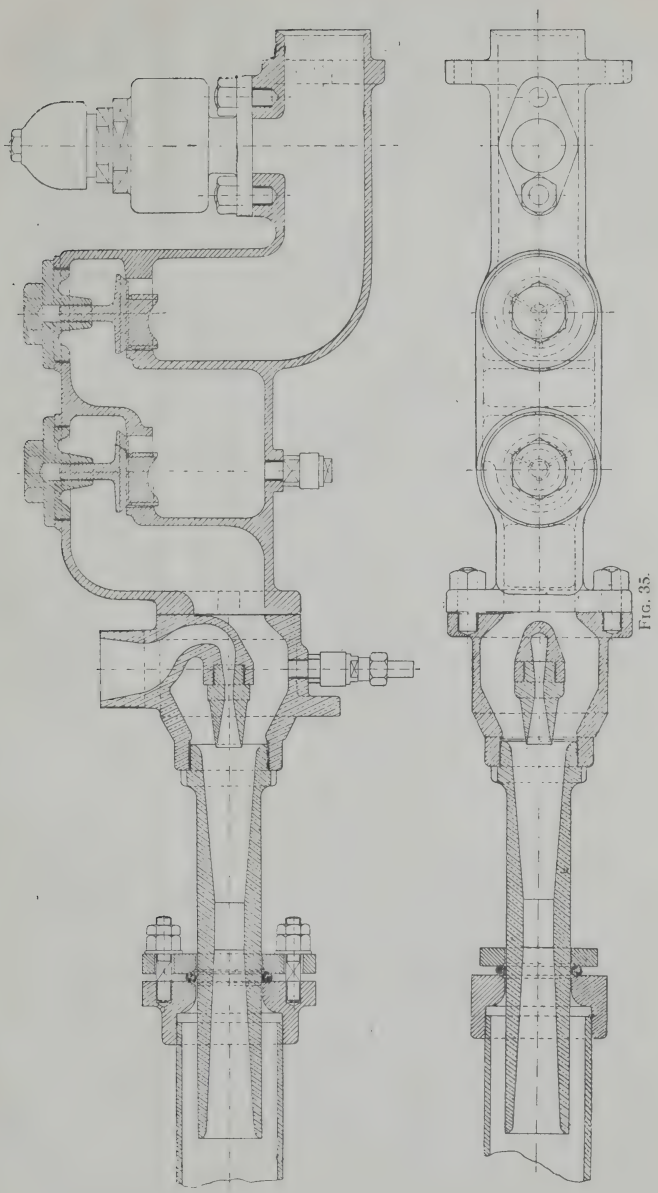


FIG. 35.

Two equilibrium valves, one on the " train " side and one on the " sack " side, are used on the engine, for the purpose of maintaining the vacuum at a constant height, which is 20 inches.

The ejector employed on the L. & N.W.R. is shown in section, Fig. 35.

The carriage brake cylinder is illustrated at Fig. 36, and differs from the usual standard brake cylinder in many important essentials. The brake cylinder is called a " sack," and resembles to some extent the " Hardy " brake cylinder formerly used in conjunction with obsolete forms of vacuum brakes in this country. It is placed horizontally and not vertically on the carriage under-frame. It is double acting, and pulls direct on to the brake rigging from each end. The diaphragms in the cylinder are made of rubber sheeting.

Each carriage has an automatic controlling valve, similar in design to the standard pattern. A pipe leads from the ball valve casing to the centre of the brake cylinder at A, and another connects the former to each end of the brake cylinder at BB. Whilst a vacuum is being maintained air is withdrawn from both ends and from the middle of the sack, holding the diaphragm in equilibrium. When the vacuum is destroyed in the train pipe, air is admitted to the ends of the brake cylinder, but is prevented from entering the central chamber by the action of the ball valve. To release the brakes, the air is again exhausted by means of the ejector, and the diaphragms return to their normal position by aid of powerful spiral springs placed inside the brake cylinder surrounding the piston-rod. The piston-rods move freely in the boss of the stays that support and strengthen the sides of the cylinder.

Whilst on the London and North-Western Railway stock this " sack " cylinder is used, standard brake cylinders are used on nearly all the vehicles of the West Coast Joint Service.

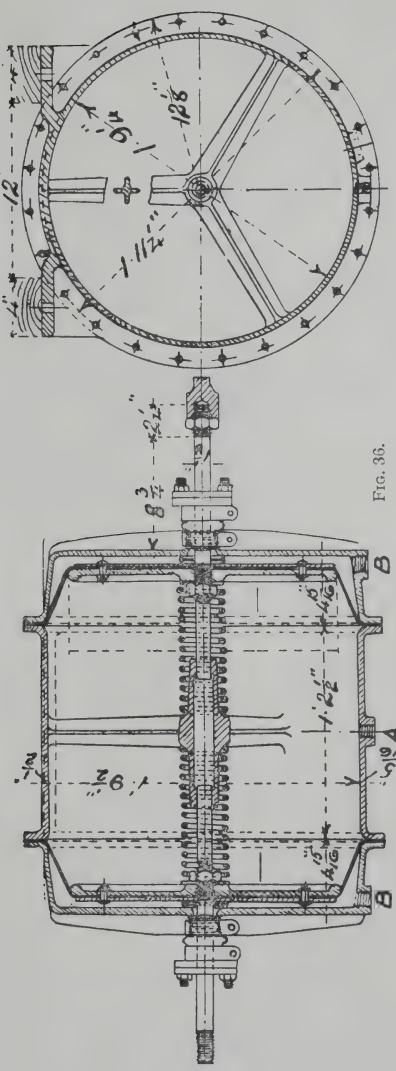



Fig. 36.

## VACUUM AUTOMATIC BRAKE ON THE L. & Y. RLY.

THE Lancashire and Yorkshire Railway use the standard type of Combination Ejector, but the brake cylinders are of the diaphragm type, although just a few are still fitted with rolling ring cylinders.

Figure 36A shews a section of the type used on the locomotives, and these cylinders are fixed in a vertical position. The top side of the piston, or vacuum

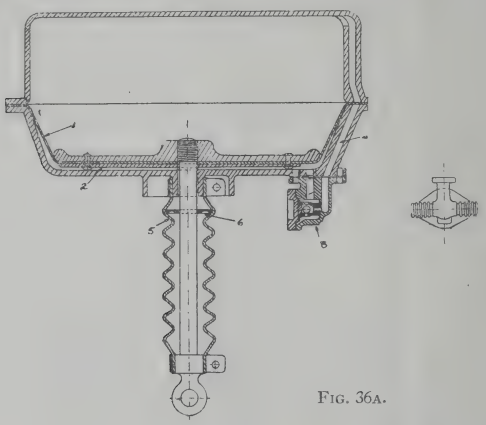


FIG. 36A.

chamber, is separated from the lower half of the cylinder by means of an india rubber diaphragm (1), rivetted on to the underside of the piston, and held firmly in position by a metal plate (2). The outer edge of the diaphragm is securely fastened and made air-tight between the top and bottom halves of the cylinder, which are bolted together.

A ball valve (3) is attached to the cylinder through which communication is formed between the train pipe, vacuum chamber and the reservoir. The passage (4) forms the connection to the vacuum chamber above the piston. To prevent leakage past the piston rod, instead of the usual gland, an india rubber sleeve (5) has been installed, inside of which metal discs (6) are placed, which enables the sleeve to fold correctly when the piston rod moves inwards, and the brakes are being applied. A

reservoir is provided on the tenders to give additional braking power.

Figure 36B shews the type of cylinder and arrangement of vacuum pipes on carriage stock. The

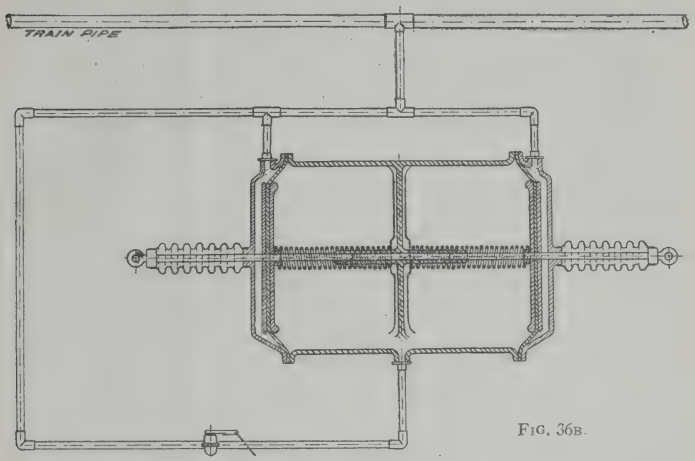



FIG. 36B.

cylinder resembles very much the type used on the L. & N.W. Railway.

The cylinder is placed horizontally on the carriage underframe, and is double acting, pulling direct from each end. The details are the same as in the case of the single cylinder, except that a ball valve is attached to the chamber pipe instead of the cylinder.

When air is admitted to the train pipe the ball valve closes, and communication to the vacuum chamber is shut off, the pistons then move inwards, and the brakes are applied. As soon as vacuum is again created in the train pipe the pistons move to the outward position, under the influence of the springs, and the ball valve allows of communication to the centre of the cylinder, so that any air that may have escaped into the chamber is withdrawn. A wire is attached to the lever of the ball valve, which enables the valve to be operated by hand, should any case arise when it is necessary to release the brakes on a carriage that has been detached from a locomotive.

## FITTING UP AND WORKING OF THE VACUUM AUTOMATIC BRAKE.

IN fitting up brake cylinders of the standard combined or separate types it is important that the lever of the brake shaft is exactly parallel with the trunnions on which the cylinder swings, so that no side or cross strains are set up. The trunnions should be an easy fit in the hangers, but no lateral clearance should be allowed; similarly the brake shaft should have no side play in its bearings.

Heavy brake shaft levers should be suspended in such a manner that their weight does not rest on the pin at the bottom of the hole in the piston rod crosshead when the brake is "off." As explained in the Note on the "separate" type of brake cylinder (page 24), the end of the rod is slotted to allow for this.

The gear and rigging should be perfectly free, so that the brake falls "off" without any assistance from the piston.

It is most important that a clearance of $\frac{3}{8}$ in. is allowed in the brake shaft lever jaw at *each side* of piston head whether the ends are of the "Hook" or "Jaw" type.

All piping for the vacuum brake should be as direct as possible, with a minimum of bends, angles, etc., as all these increase the resistance to the air either in admission for applying the brake or in extraction for release.

Brake cylinders should receive periodical examination in order to ascertain the condition of the rolling ring and piston rod gland packing. The frequency of this inspection must be determined by the class of service.

As already noted when putting on a ring, it must be carefully noted that it lies fairly and evenly on the piston. The correct alignment can be secured by pulling the ring slightly away from the "drum" of the piston with the thumb and finger of each hand on opposite sides.

The piston rod gland packing ring should grip the piston rod sufficiently tight to prevent the latter falling by its own weight; when it fails to do this it should be renewed.

In putting together a standard cylinder care should be taken that the "air cap" and rubber washer (see Fig. 14) are placed over the piston rod and also that the joint ring between the flanges of the vacuum chamber and cylinder head is in correct position. If there is any difficulty in retaining this in exact alignment whilst the cover is being brought up, a simple method of holding it in position is to place a few dabs of soft soap in the groove and press the joint ring on to them. In tightening up the cover joint, the bolts should be screwed up evenly all round and not too tightly, or there is a risk of the cylinder being drawn out of shape. The correct procedure is to tighten the nuts up finally when a vacuum exists in the cylinder, then all that is necessary is to bring the nuts up to the lugs with only as much pressure as will be given with a short spanner not more than 6 ins. long.

On the running-shed enginemen's notice board is very often seen the following notice:—

> "Several cases have occurred lately where a quantity of oil has been found in the engine brake cylinder; this has evidently found its way there through the large ejector.
>
> "This practice is liable to bring about a brake failure, and it must be stopped at once."

When an engineman mounts the footplate in the shed and finds steam being raised in the boiler and the ejector is becoming warm, he should have no difficulty in getting it to work freely. The nuts should not be too tight on the application disc, or the fork of the application handle will become unduly strained, and probably cause the disc to spring open. More than one ejector has been spoilt in this way. Tighten the nuts so that they become just locked and no more. This tightening will have

to be increased or relaxed as the boiler becomes warmer and steam is admitted into the ejector.

If the ejector is found faulty, the steam supply must be shut off, the application disc and handle removed and the glands and cones examined; sometimes the cones are found to be at fault, whilst on other occasions the moving discs are defective, the working faces having become cut, owing, no doubt, to excessive tightening of the nuts on the application handle. If either of these faults exist the defective parts must be replaced. It is a good plan to apply to the shed foreman and to obtain from him knowledge as to the working of the ejector on a particular engine, if such has just come out of the shops.

In every well-conducted running-shed the foreman should know approximately by referring to his " repair book " when any particular engine went for repairs to the shops last, and whether there was any special remark made against the brake apparatus.

Sometimes the flexible pipe coupling between the engine and tender becomes damaged, or between certain of the vehicles, then it becomes necessary to accord treatment explained later.

When lubricating the ejector, do so with refined mineral oil, and introduce it through the special opening at the back provided with a cock, shown at W., Fig. 2, page 5. Before opening the lubricating cock close the steam stop valve, otherwise steam will rush out.

The working vacuum should always be well maintained; if it cannot be kept up to the proper figure a leakage may be expected to be the cause of the trouble, and this should be located and corrected if possible. The guards of a train should also see that their vacuum gauges show the working vacuum, and in the event of these not doing so, the engineman must be informed, and he should " blow up " until the desired amount of vacuum is obtained.

Should a split be found on any of the hose pipes on the train whilst making a journey, a temporary mend can usually be made until a new one is obtained. This mend can be made in the following way. Procure a piece of truck sheeting or any other stout canvas or material that is handy, and wind it round the split at least three or four times, according to the length and nature of the fault. The sheeting should not be cut less that 1″ to 1½″ wide.

With fast express services a vacuum of 22″ to 24″ is necessary, especially if the train be made up of heavy vehicles.

Keep the handle of the ejector in the "running position," except when applying or releasing the brakes.

When the engine and tender have been coupled to a train, the engineman, after ascertaing that the hose-pipe between the tender and train is joined up, should immediately "blow up" and create vacuum throughout the train.

The small ejector, when a pump is not used, must be constantly at work maintaining the vacuum in the train-pipe and also securing the latter against leakages. It should never be closed whilst working the train when the engineman's handle is in the "running position." The large ejector is brought into operation only for a quick release after an application of the brakes.

Periodically the engineman should thoroughly examine all the brake gear when over a pit.

An engineman should, before leaving the engine and tender in the running sheds, pull over the application handle of the ejector to the "full on" position, and place over this and the disc, a shield as already described, locking same with the nuts. This prevents tampering with the ejector and, moreover, as pointed out previously, keeps it clean.

The hand brake should always be screwed hard on before leaving the footplate, and if any of the brake gear is known to be faulty and requires attention, a report of same should be given to the

shed foreman. Notices should be placed on the buffer headstocks both in front of engine and rear of tender, to the effect that they are "*not to be moved.*"

Careful manipulation of the brakes is necessary to prevent the wheels skidding, especially if the train be descending a gradient; "picking up" or skidding spoils the retarding effort. A sharp look-out for stop signals, signs of danger, etc., should be kept, and on perceiving either, the train should be brought under the influence of the brakes gently to reduce the speed before bringing the whole brake force into operation. The engineman should "feel" his brake power before making a "full" application, and retain it at his disposal as long as it is necessary to do so. The small ejector, of course, gradually releases the brakes on the train so that as the train comes to rest, the brake pressure is slightly diminished, The large ejector, as previously stated, is brought into use only for quickly making a "full release" when necessary. The brakes of a train, if standing on a gradient, should never be wholly released until a fresh start is to be made.

In releasing the brakes the large ejector should be be kept blowing *after* the gauge from the engine vacuum chamber shows a full 20 in. of vacuum, as there is still a considerable volume of air to be expelled before the whole system of pipes, cylinders and chambers are properly exhausted to 20-in An experimental shutting off of the large ejector at the moment the gauge shows 20-in. will illustrate this, for the needle will immediately begin to fall back according to the length of the train being operated. It should also be remembered that the vacuum gauge of an engine is close to the ejector, and, therefore, very near to its influence.

Wet rails, especially when "greasy," are very deceptive, and particular attention should be given to the application and release of the brakes at least two or three times before a final application is made; this will obviate much of the risk of skidding.

The following regulations for working the vacuum automatic brake must at all times be adhered to :—

" Engine drivers must satisfy themselves that the vacuum brake is in proper working order before starting, and at each station where the engine is changed or where any vehicle is attached or detached. It must also be tested before descending steep inclines and before passing the distant signal of a crossing station on a single line or of any terminus or other principal station at which the train has to stop, and the speed of the train must be reduced by it. Engine drivers must enter such stations, or a dead-end bay at any station, at such a speed as to enable them to stop the train at the proper place. Engine drivers of goods trains must in addition test the vacuum brake before passing the distant signal of any place at which the train has to stop."

## VARIABLE POWER BRAKE.

THE introduction of this brake gear by the Consolidated Brake and Engineering Co. is for the purpose of applying a brake block pressure commensurable with the gross weight of the vehicle and its load.

The arrangement shown on Fig. 37 is designed for a four-wheeled goods wagon, the cylinder adopted being the 21 in. " Crab " type.

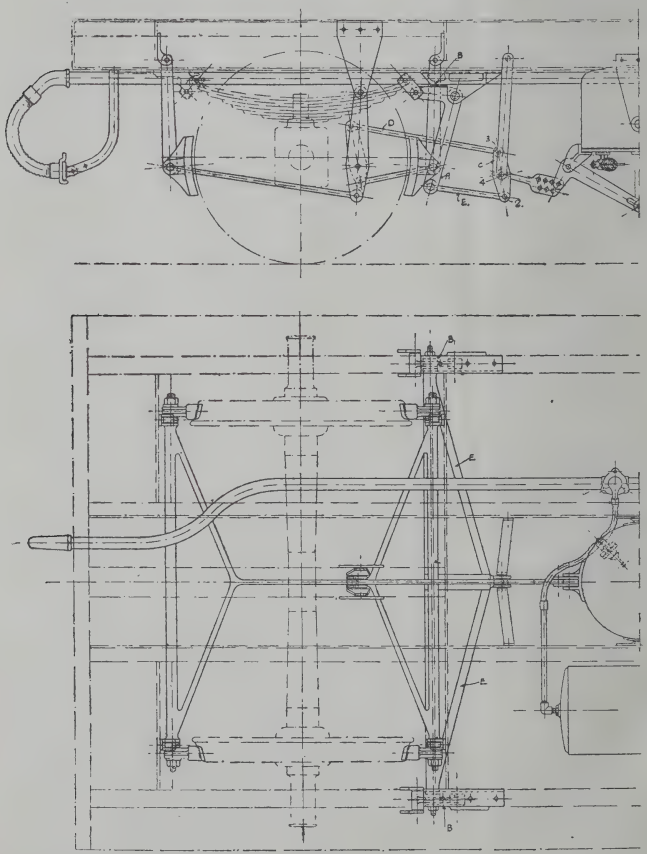


FIG. 37.

The following is a description of the working of the arrangement :—

The inside end of each bearing spring is attached to the short arm of a bell crank " A," which we call the variable power lever.

In the normal, or " brake off " position, this lever bears against a stop " B," the weight of the vehicle holding it firmly to this position.

On the application of the brake, the blocks are first drawn to the wheels through the lever " C," which we call the distribution lever, and pull rod " D," the other end " 2 " of the distribution lever " C " being the fulcrum. As soon as the blocks are drawn to the wheels and the brake application is of sufficient power, the fulcrum point of the distribution lever " C " is changed over to " 3 ", and the end " 2 " by means of pull rod " E " draws the variable power lever " A " from its stop " B " and lifts the vehicle slightly off the spring, the piston having run its full stroke.

Immediately this occurs, the centre " 4 " of the distribution lever " C " becomes the fulcrum about which the loaded vehicle distributes to the brake blocks a pressure directly in proportion to the load, any increase or decrease in the latter creating a corresponding variation in the brake power.

It should be emphasised that under these conditions it is the vehicle and its load which are responsible for the pressure at the blocks, acting through the variable power lever " A," pull rod " E," distribution lever " C," and pull rod " D," etc., the whole being balanced about the fulcrum "4" of the distribution lever " C."

If the load on the vehicle is greater than the maximum cylinder power will balance, then the variable power lever " A " will not move from the stop " B," and the full cylinder power will be developed, giving the maximum block pressure, the action of the brake apparatus acting in the usual way.

Particular attention is called to the fact that no

other adjustment is required than that usually necessary with regard to the proper length of the pull rods to ensure the correct clearance of the brake blocks.

Any variation in the camber of the bearing springs in no way affects the proper working of the apparatus.

## "QUICK PULL ON" BRAKE AND WEAR COMPENSATOR.

The object of this apparatus is to draw the brake blocks to the wheels quickly, by means of a small auxiliary cylinder, before the main cylinder comes into operation.

Thus block clearance, wear and all slackness in pin joints, etc., are gathered without the usual loss of efficiency in the power cylinder, due to the comparatively long stroke necessary to accomplish this in the ordinary brake arrangement.

Fig. 38 shows a general arrangement as fitted to a 4-wheeled vehicle.

On exhaustion taking place in the train pipe in the usual way, a vacuum is created in the auxiliary cylinder through connection 1, in which a known type of band piston is used, and in the power cylinder through connection 2, back pressure valve 3, and connection 2B.

On an application of the brake being made by the reduction of vacuum in the train pipe, the piston of the auxiliary cylinder moves forward, drawing the blocks to the wheels by a suitable arrangement of levers and pull rods. The toothed rack 4 forming an extension of the piston rod also moves outwardly at the same time.

When the brake blocks engage with the wheels and a certain amount of pressure is applied the slotted brake block 14 attached to the truss beam 5, under the influence of the friction between the blocks and the wheel tyre, will rise or fall according to the direction of rotation.

This being permissible by the slot in brake block 14 carried by hanger 6.

The vertical link 7 is attached at its lower end to the brake block 14 through levers 15 and 16 forged or keyed on rocking shaft 17 and by links 18. The

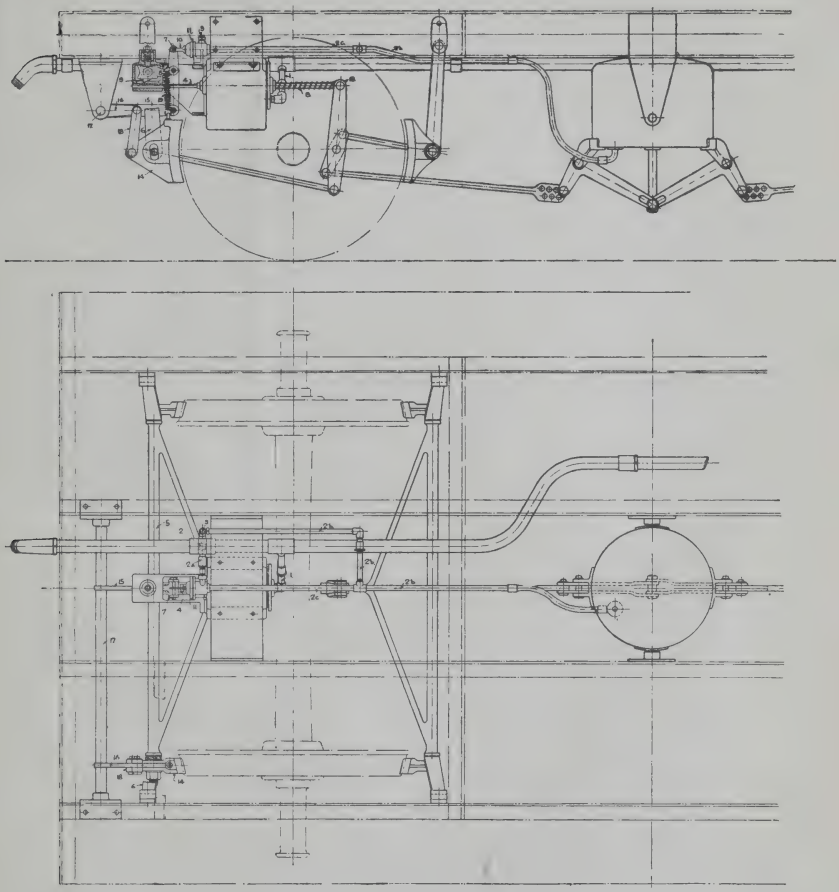


Fig. 38.

weight of slotted brake block being carried by spring 19 and links 18, hence the rise or fall operates the short lever 8, which engages the tooth 9 with the rack 4 ; at the same time the tee-lever 10 is moved,

thus opening the valve 11, admitting air from the train pipe through connections 2, 2A, and 2C to the power cylinder.

The brake is then applied with increased force by this cylinder, the end 12 of the vertical brake lever becoming a fulcrum point.

In releasing the brake, the valve 11 remains open until the block pressure has decreased to such an extent that the truss beam again takes up its normal position, the valve closes, the tooth 9 is disengaged from the rack 4, and the brake is eventually released, the fulcrum point 12 being moved back to normal under the influence of the spring 13, and the power cylinder being completely released by the exhaustion of the underside of the piston taking place through the back-pressure valve 3.

## AUTOMATIC VACUUM BRAKE FOR ELECTRIC ROLLING STOCK.

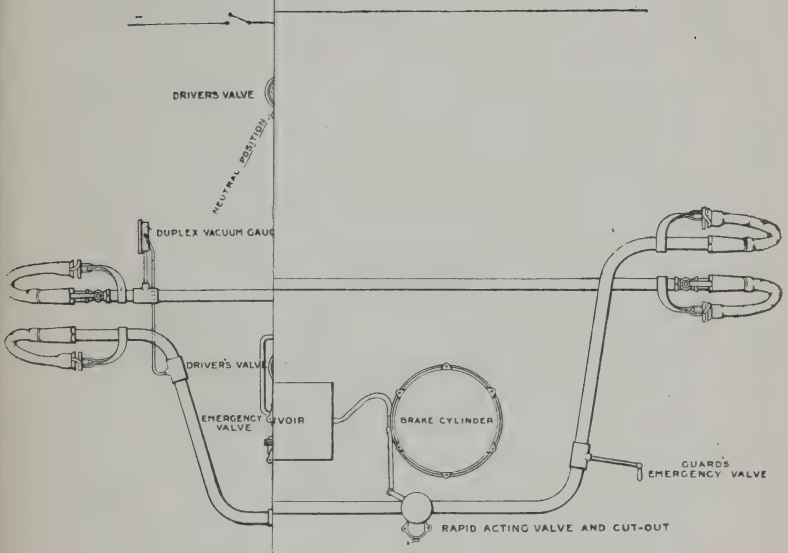
FIG. 39 shows the arrangement of automatic vacuum brake apparatus for motor coach, introduced by the Consolidated Brake and Engineering Company.

The driver's brake handle is arranged with dead stops for the " release " and " emergency " positions, thus no time is lost or doubt arise in taking up these important positions.

The usual working vacuum of 20 inches is obtained throughout the main train pipe side of the system, which includes the brake cylinders and cylinder reservoirs, while on the release side, including the release reservoirs, a vacuum of 26 inch and upwards is created.

On an application of the brake, air is admitted to the underside of the brake cylinders in the ordinary way.

On the release taking place, both pipe lines are thrown open to each other through the driver's valve, and " release valves " throughout the train. The air in the main train pipe side is withdrawn




*To face page* 96

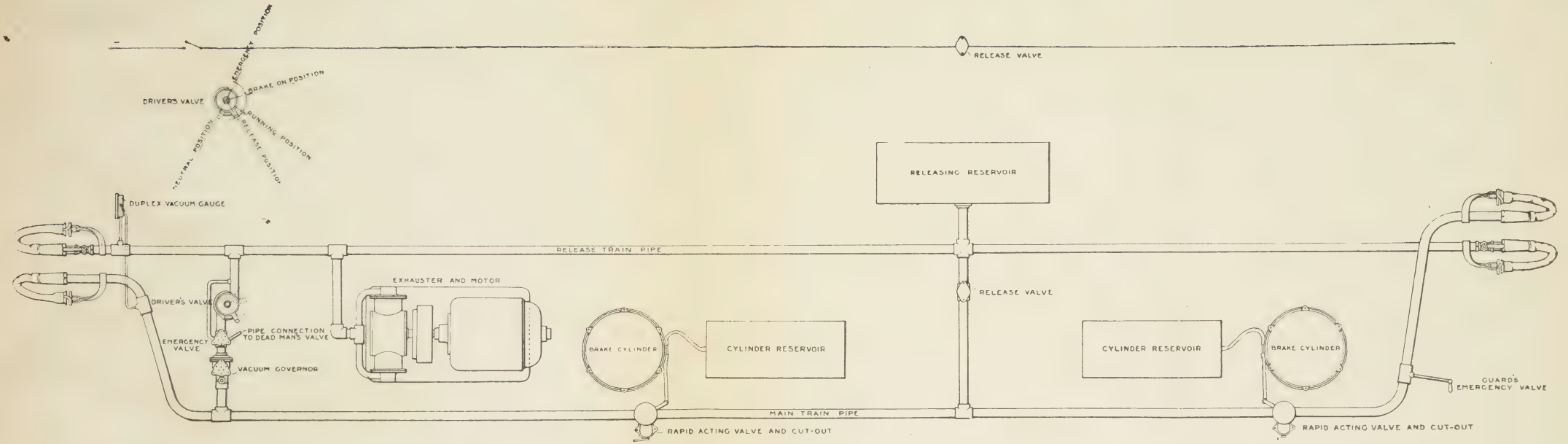



FIG. 39.

*To face page* 96

at several points simultaneously, under the influence of the existing " high " vacuum in the release reservoirs in addition to the direct suction of the several exhausters, thus a very rapid release of the brake is obtained.

The operation of the dead-man's handle of the master controller will cause an " emergency " application of the brake, through the medium of the emergency valve.

The exhausters are run continuously, at one speed only, during the time the train is in service, this in no way interfering with the operation of the brake in all its functions.

The duty of the governor valve is to maintain the working vacuum of 20 inch in the main train pipe side of the system, when the brake is under running conditions, at the same time allowing the vacuum on the release side to be increased to the maximum, *i.e.*, 26 inch or more.

The vacuum brake apparatus on the driving trailer will be identical with that on the motor coaches, with the exception that no exhauster will be required.

For trailer coaches without driving compartments, in addition to the elimination of the exhauster, none of the usual fittings, valves, gauges, and pipe connections of the driver's compartment will be required.

## VACUUM BRAKE EQUIPMENT ON THE L. & Y. RLY., MANCHESTER & BURY ELECTRIFIED SECTION.

FIG 40 shows the general arrangement of the vacuum brake equipment on the M. & B. Section of the L. & Y. Rly. Co.'s latest electrification.

With this system the brakes on a five car train can be released in twelve seconds. A brake valve is placed in each motorman's compartment and is connected to the train pipe. A high speed ball

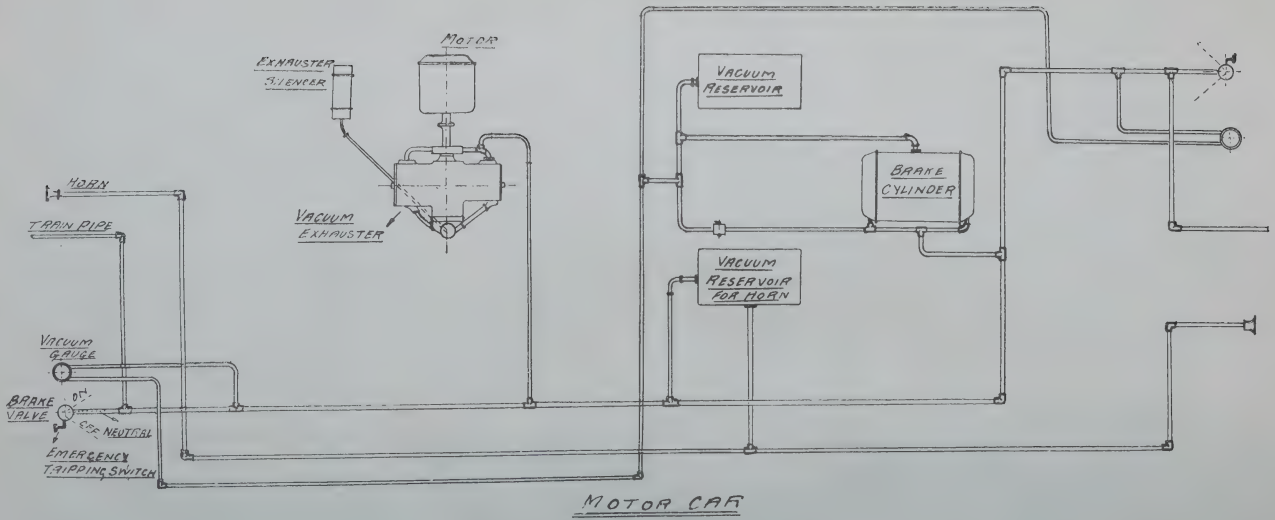

MOTOR
EXHAUSTER SILENCER
VACUUM EXHAUSTER
VACUUM RESERVOIR
BRAKE CYLINDER
VACUUM RESERVOIR FOR HORN
HORN
TRAIN PIPE
VACUUM GAUGE
BRAKE VALVE
OFF
CUT OUT
NEUTRAL
EMERGENCY TRIPPING SWITCH
MOTOR CAR

FIG. 40

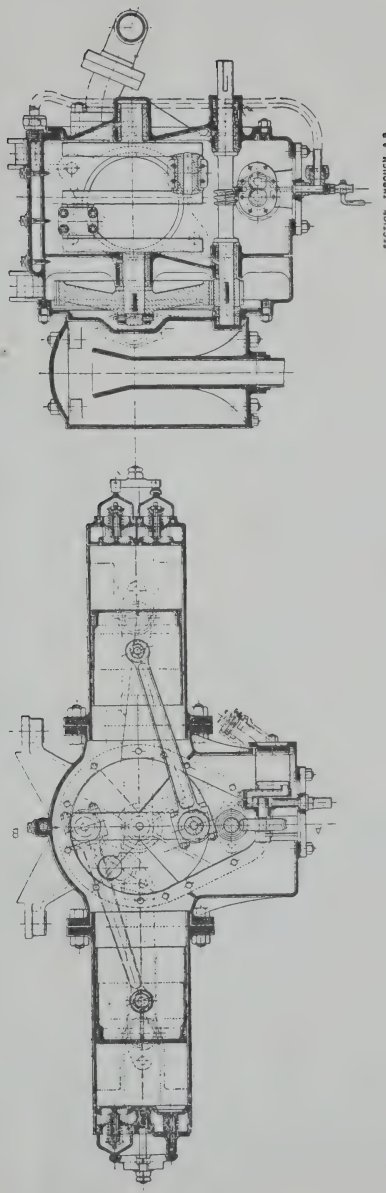



FIG. 42A.

valve is used between the brake cylinder and the vacuum reservoir, also an extra reservoir has been installed for the motor car horn so as to enable the horn to be used should a failure of current take place. On the connection to this reservoir from the train pipe a non-return valve has been installed, so as to prevent air reaching the reservoir when the train pipe is open to the atmosphere.

A 5 h.p. motor drives the exhauster pump by means of flexible leather couplings. The speed of the motor is 1,000 revs. per minute, and they are fitted with ball bearings at each end.

The exhauster, Fig. 41, has two cranks working at 180 deg., and at one end of the crank shaft a heavy spur wheel 1 is attached, which gears with the driving pinion 2 ; this spur wheel acts as a fly wheel, which reduces vibration to a minimum. A worm 3 drives an oil pump 4 for lubricating all working parts of the exhauster. The oil is fed through a pipe 5 to the top of the crank chamber, and thence it flows on to the bearings through nozzles, and finally drains back to the crank chamber passing through a strainer and again used. Separator 6 is attached to the side of the pump into which the exhaust air and oil spray passes ; the air then passing to the silencer, and the oil to the crank chamber. The inlet and outlet valves 7 are places in the cylinder head. The pump motor is operated by a regulator and electrical switch. It cuts in at 18 ins. of vacuum and out at 23 ins.

The brake valve includes the vacuum pump control switch and dead-man's handle, and for those compartments which are not occupied by the motorman it performs the simple function of an ordinary guard's van brake valve, that is, the brakes can be put on but not released.

The motorman must retain his hold on the " dead-man's handle " when running. In the event of him releasing it the handle will rise, and by means of the tripping switch below, current to the main motors is cut off, the brake is applied, and if the pump motors are running they are stopped.

## SLIPPING CARRIAGES.

FIG. 42 shows a drawing of the slip apparatus for carriages, and which is one of the best forms, being simple and easily understood and, moreover, there should be no difficulty experienced in operating it.

It will be noticed that the slip portion of the hook, works on a pin, passing through the main

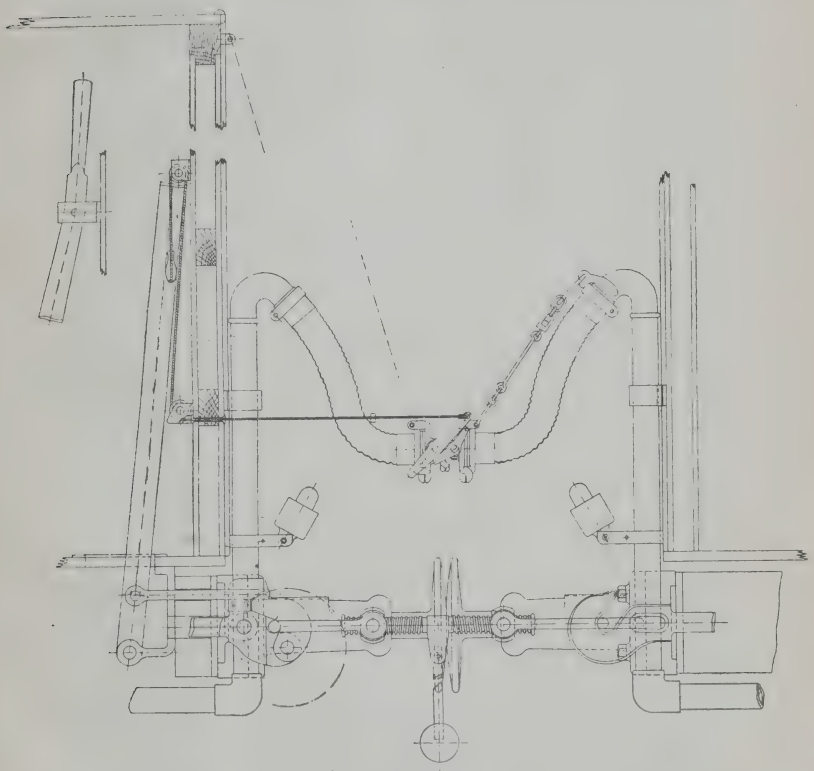


FIG. 42.

portion of the draw-bar or that part which is directly connected to the draw-bar gear under the carriage body. This draw-bar passes through a steel plate fixed to the headstock of the under-framing. The slip or drop portion of the hook is kept from falling

away from its normal position by means of a sliding bar, which is case-hardened to prevent undue wear to its working surfaces ; this sliding bar is fixed at one end to a lever in the guard's van and the other end rests and bears on the slip or drop portion of the hook. This sliding bar operates the slip apparatus so far as the hook and screw coupling are concerned. The guard on pulling the lever (which is kept in its normal position by a pin passing through both lever and bracket, which latter is fixed to the end inside the van, or an ordinary trigger, with spring ratchet and slot may be provided with the lever, the trigger fixing in a slot when the slip apparatus is not in use) towards him causes the sliding bar to come away from the slip or drop portion of the hook, and the latter falls, leaving the shackle of the screw coupling free to fall away, and thus the connection between two portions of the train is broken.

With this form of slip apparatus no special care is required as to the slip-coupling, *i.e.*, it is not required to detach and return it to the depot where it belongs ; this is generally the case unless a special guard's van is put aside for attaching to the slip portions of trains only ; moreover, special screw couplings are necessary with other forms of slip apparatus. Another slip coupling has a hinged shackle which is kept closed by a catch held in position by a spring. This coupling is slipped or operated by the guard pulling a cord or chain attached to the locking catch or trigger, which, when released, allows the hinged end of the shackle to fall away from the draw-hook.

The slip-coupling mentioned first is known as " The Hinged Draw-hook System," the other is " The Spring Lock Shackle System."

It is usual for some railway companies to provide a window at the rear end of the van, so that the guard on lowering this may operate the slip coupling if the spring lock shackle system is in use. The guard by simply pulling the chain or cord which is hanging slack from a hook on the end of the van

outside and attached, as already mentioned, to the locking catch on the slip shackle, causes the catch or trigger to come away and the " slip " is made.

It may be mentioned that the hinged draw-hook system of slip coupling is constructed throughout of the best Yorkshire scrap iron, and all wearing surfaces case-hardened, including the pins. Mild steel is sometimes used, as with it there is less risk of splitting or lamination, especially in the case of hinges or other details which have to be forked and made with nearly square corners in the direction or parallel with the length of the bar. It is safer perhaps to employ wrought iron for all draw-bar gear, especially hooks, shackles, etc. Screw couplings should be made to stand a breaking strain of 35 to 40 tons, and the shackle should be made of high-class chain or cable iron, B.B. or B.B.B. nuts to be made of best Yorkshire scrap, so also the lever and screw; the ball attached to the lever should be of cast iron and not less than 3″ in diameter.

" The spring lock shackle " is constructed of the same material as the hinge draw-hook apparatus, except that the locking catch or trigger, is made of gun metal, so as not to become corroded from exposure to the atmosphere.

Before proceeding to explain the special apparatus required for the vacuum automatic brake when slipping carriages, it would be as well to mention one or two hints relative to the proper care and management that the slip hook and couling apparatus requires.

When the slip portion of a train is being made up, the screw coupling between the two portions should never be screwed up as tight as it will go, for this reason, if a very tight contact is made the drop or slip portion of the hook will be forced up against the sliding bar by the outward force of the shackle pulling against it, when the train is in motion, and the guard may find great difficulty in pulling over the lever to make the slip, and possibly he will not be able to do so at all. Occasions have been known

where the slip portion of a train has been carried on past the slipping place, and the reason for this has afterwards been found due to the screw coupling being too tight. When screwing up, the coupling should be left with a very slight slackness in the shackle falling into the drop or slip portion of the hook. Give all the working parts of the slip coupling a good coat of oil, and pay particular attention to the pin which acts as a hinge to the slip hook passing though that and the main portion abutting on the draw-bar gear. Any fracture or stiffness in the working parts of the slip coupling apparatus must be attended to without delay, and if there be any serious fracture it must be reported to the carriage examiner at once.

The van which has the lever for operating the slip coupling apparatus should have its door locked until the guard is ready to enter it at the starting of the train.

The guard in charge of each slip portion is held responsible for seeing that the brake, slipping, and other apparatus are in good working order by a thorough examination and testing before the train starts, and that the prescribed slip carriage signals are attached.

Fig. 43 shows the special slip-cocks employed when it is required to slip a portion of a train fitted with the vacuum automatic brake. As already explained, there are no stop-cocks ordinarily used with the vacuum brake system, but it is necessary that the train-pipe should be properly closed when it is desired to slip any portion of a train. Cocks are therefore provided constructed entirely of gun metal. They are marked "Train" and "Slip carriage," and must be placed between the universal hose coupling lugs when attaching the slip portion of a train. The cock marked "Train" should be placed next to the portion fast to the engine, and the cock marked "Slip Carriage" next to the slip portion of the train. After the train is made up these cocks should be examined

to see that they move freely and are placed in position with the levers pointing towards the train, or that part which is made fast to the engine. When the levers are in such a position the train-pipe is open throughout, so that all the brakes can be controlled by either engineman or guard.

To test these cocks properly, the guard should notify the engineman that he requires him to "blow up" or create a vacuum by means of the

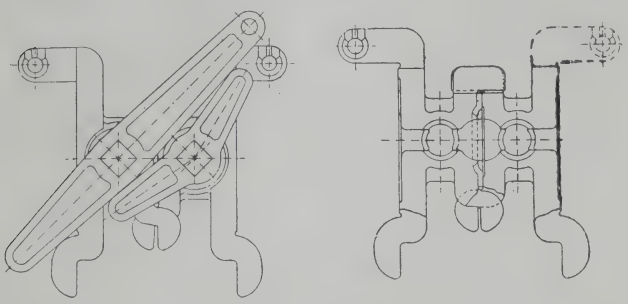


Fig. 43.

ejector to at least 23″, or the usual running vacuum maintained by any railway for their train service. When the guard's vacuum gauge shows nearly 23″ the action of the ejector can be dispensed with, and then the guard pulls the cord and brings the levers over towards the slip van, thus shutting off entirely the connection of the brake pipes between the slip portion and train, then the slip cocks should be disjointed, which is done by lifting them in exactly the same manner as the ordinary universal hose coupling lugs. When this disjointing has been made the guard watches his gauge in the van of the slip portion to see that the vacuum is properly maintained, and that no leakage ensues; if the vacuum does not fall, then he knows that the cocks are in good order and that they can be rejoined together in readiness for the slip to be made during the journey.

When the train approaches the station at which the "slip" carriages have to be left, the guard in

charge of the "slip" portion must observe the signals, and, if all right and the train is running at the usual speed, he must apply the hand brake so that the blocks press slightly on the wheels. He must then, and not before, uncouple the "slip" portion, and immediately afterwards apply the hand brake a little more forcibly so as to allow the train to get some distance from him.

When the guard of the train receives the intimation from the "slip" guard that the "slip" has been satisfactorily made, he must give the engine driver an "All Right" signal, a green flag by day or a green light by night, and the engine driver must acknowledge the signal. The guard in charge of the "slip" portion may then release the hand brake in order to run to the platform.

The slip must not be made if the driver is slackening speed or until the proper signals are shown for the train to pass through the station.

Except in cases of emergency the continuous brake must not be used by the "slip" guard after "slipping" unless there is a special arrangement for so doing provided.

When making the "slip," the guard does precisely the same as when testing the apparatus before starting on the journey; he pulls the cord closing the valves at both ends of the train-pipe and, as the train parts, the lug-couplings separate; no harm is done to the latter when they are forcibly drawn apart, as they are constructed to permit of this action.

The arrangement of "slip" apparatus in use on the G.W.R. is shown in Figs. 44 and 45.

In order to make a "slip," the guard must pull the lever right back to the "Slip and Brake On" position, which releases the "slip" hook and applies the vacuum brake on the "slip" portion of the train, causing the "slip" portion to immediately fall away from the main train and the hose pipes to be pulled apart, the vacuum on the main train being automatically sealed by a spring valve when

the pipes are separated. Then by putting the lever back to the midway or " Brake Released " position (where it is stopped by means of a pawl engaging in a notch) the vacuum brake can be released as

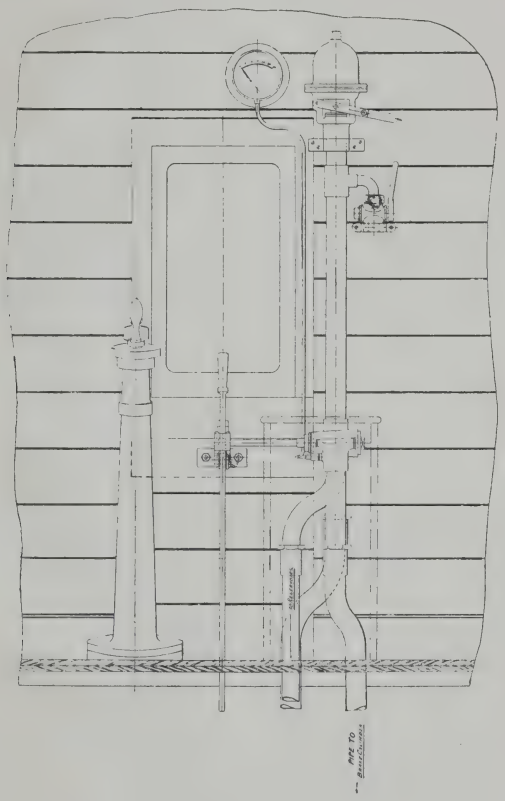


Fig. 44.

extra chambers are provided to ensure a reserve of power, and the " slip " guard has it in his power by manipulating the lever between the upright or " Brake Released " position and the " Brake On " position to apply and release the brake at will.

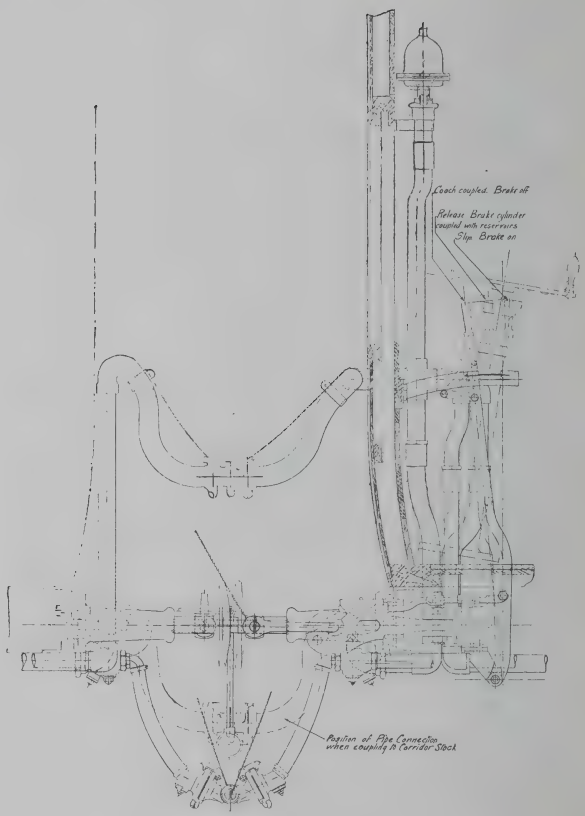

Coach coupled. Brake off
Release. Brake cylinder coupled with reservoirs
Slip. Brake on
Position of Pipe Connection when coupling in Corridor Stock

Fig. 45.

# The Vacuum Brake Co., Ltd.

Train of 50 Wagons fitted with Vacuum Automatic Brake,
Great Indian Peninsula Railway.

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SEAMLESS CYLINDER CASINGS.
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"WROT" STEEL COUPLINGS.
IMPROVED PISTON RODS.
"GRILLE" HOSE PIPES.
QUICK-ACTING BRAKE.
IMPROVED RAPID RELEASE BRAKE FOR ELECTRIC ROLLING STOCK.

---

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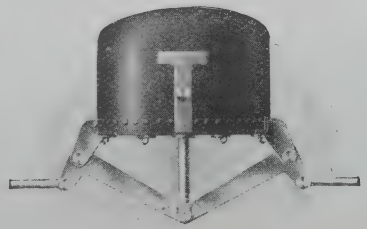
# Improved Vacuum Brake Apparatus

## "CRAB" CYLINDER AND RIGGING

*(Patented)*

GREAT SAVING IN WEIGHT OF RIGGING.

BLOCK PRESSURES COMPENSATED.



NO BRAKE SHAFT.

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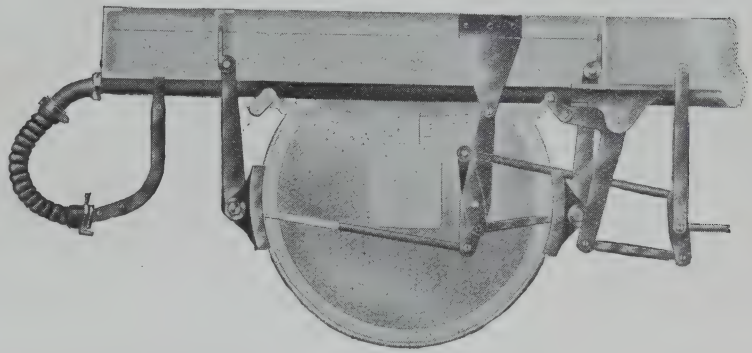
The Brake Power varies **Automatically** in accordance with the Load Carried.



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# Railway Publications.

## The Locomotive Publishing Co., Ltd.,
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